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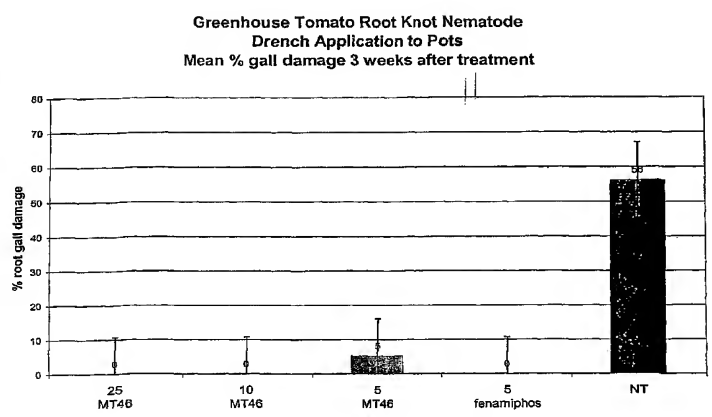

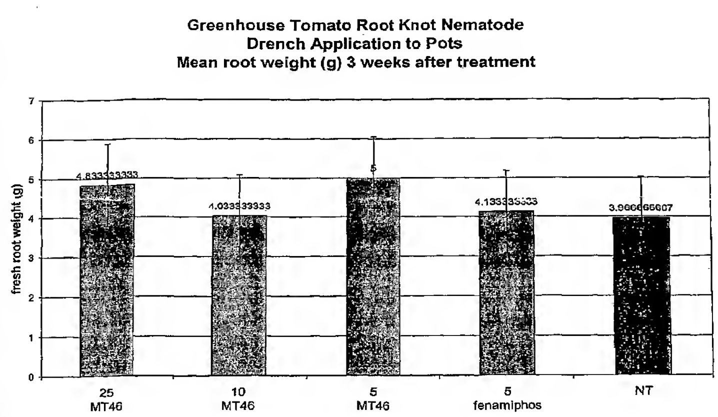

(57) Abstract: Certain chemical analogs and related compounds useful in the control nematodes and other pests that infest plants or the situs of plants are described. Nematodes and other pathogens that parasitize animals can also be controlled using the methods and compounds of this invention.

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Pesticidal Compositions and Methods

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. application serial no. 11/002,707, filed December 1, 2004, the entire contents of which are incorporated herein.

BACKGROUND

Nematodes (derived from the Greek word for thread) are active, flexible, elongate, organisms that live on moist surfaces or in liquid environments, including films of water within soil and moist tissues within other organisms. While only 20,000 species of nematode have been identified, it is estimated that 40,000 to 10 million actually exist. Some species of nematodes have evolved to be very successful parasites of both plants and animals and are responsible for significant economic losses in agriculture and livestock and for morbidity and mortality in humans (Whitehead (1998) *Plant Nematode Control.* CAB International, New York).

Nematode parasites of plants can inhabit all parts of plants, including roots, developing flower buds, leaves, and stems. Plant parasites are classified on the basis of their feeding habits into the broad categories: migratory ectoparasites, migratory endoparasites, and sedentary endoparasites. Sedentary endoparasites, which include the root knot nematodes (*Meloidogyne*) and cyst nematodes (*Globodera* and *Heterodera*) induce feeding sites and establish long-term infections within roots that are often very damaging to crops (Whitehead, *supra*). It is estimated that parasitic nematodes cost the horticulture and agriculture industries in excess of $78 billion worldwide a year, based on an estimated average 12% annual loss spread across all major crops. For example, it is estimated that nematodes cause soybean losses of approximately $3.2 billion annually worldwide (Barker et al. (1994) *Plant and Soil Nematodes: Societal Impact and Focus for the Future.* The Committee on National Needs and Priorities in Nematology. Cooperative State Research Service, US Department of Agriculture and Society of Nematologists). Several factors make the need for safe and effective nematode controls urgent. Continuing population growth, famines, and environmental degradation have heightened concern for the sustainability of agriculture, and new

government regulations may prevent or severely restrict the use of many available agricultural anthelmintic agents.

There are a very small array of chemicals available to control nematodes (Becker (1999) *Agricultural Research Magazine* 47(3):22-24; US Pat. Nos. 6,048,714). Nevertheless, the application of chemical nematicides remains the major means of nematode control. In general, chemical nematicides are highly toxic compounds known to cause substantial environmental damage and are increasingly restricted in the amounts and locations in which then can be used. For example, the soil fumigant methyl bromide which has been used effectively to reduce nematode infestations in a variety of specialty crops, is regulated under the U.N. Montreal Protocol as an ozone-depleting substance and is scheduled for elimination in 2005 in the US (Carter (2001) *California Agriculture*, 55(3):2). It is expected that strawberry and other commodity crop industries will be significantly impacted if a suitable replacement for methyl bromide is not found. Similarly, broad-spectrum nematicides such as Telone (various formulations of 1,3-dichloropropene) have significant restrictions on their use because of toxicological concerns (Carter (2001) *California Agriculture*, Vol. 55(3):12-18).

The macrocyclic lactones (e.g., avermectins and milbemycins) and delta-toxins from *Bacillus thuringiensis* (*Bt*) are chemicals that in principle provide excellent specificity and efficacy and should allow environmentally safe control of plant parasitic nematodes. Unfortunately, in practice, these two nematicidal agents have proven less effective in agricultural applications against root pathogens. Although certain avermectins show exquisite activity against plant parasitic nematodes, these chemicals are hampered by poor bioavailability due to their light sensitivity, degradation by soil microorganisms and tight binding to soil particles (Lasota & Dybas (1990) *Acta Leiden* 59(1-2):217-225; Wright & Perry (1998) Musculature and Neurobiology. In: The Physiology and Biochemistry of Free-Living and Plant-parasitic Nematodes (eds R.N. Perry & D.J. Wright), CAB International 1998). Consequently despite years of research and extensive use against animal parasitic nematodes, mites and insects (plant and animal applications), macrocyclic lactones (e.g., avermectins and milbemycins) have never been commercially developed to control plant parasitic nematodes in the soil.

Bt delta toxins must be ingested to affect their target organ, the brush border of midgut epithelial cells (Marroquin et al. (2000) *Genetics*. 155(4):1693-1699).

Consequently they are not anticipated to be effective against the dispersal, non-feeding, juvenile stages of plant parasitic nematodes in the field. Because juvenile stages only commence feeding when a susceptible host has been infected, nematicides may need to penetrate the plant cuticle to be effective. Transcuticular uptake of a 65-130 kDa protein - the size of typical *Bt* delta toxins - is unlikely. Furthermore, soil mobility is expected to be relatively poor. Even transgenic approaches are hampered by the size of *Bt* delta toxins because delivery *in planta* is likely to be constrained by the exclusion of large particles by the feeding tubes of certain plant parasitic nematodes such as *Heterodera* (Atkinson et al. (1998) Engineering resistance to plant-parasitic nematodes. In: The Physiology and Biochemistry of Free-Living and Plant-parasitic Nematodes (eds R.N. Perry & D.J. Wright), CAB International 1998).

Fatty acids are a class of natural compounds that have been investigated as alternatives to the toxic, non-specific organophosphate, carbamate and fumigant pesticides (Stadler et al. (1994) *Planta Medica* 60(2):128-132; US Pat. Nos. 5,192,546; 5,346,698; 5,674,897; 5,698,592; 6,124,359). It has been suggested that fatty acids derive their pesticidal effects by adversely interfering with the nematode cuticle or hypodermis via a detergent (solubilization) effect, or through direct interaction of the fatty acids and the lipophilic regions of target plasma membranes (Davis et al. (1997) *Journal of Nematology* 29(4S):677-684). In view of this predicted mode of action it is not surprising that fatty acids are used in a variety of pesticidal applications including as herbicides (e.g., SCYTHE by Dow Agrosciences is the C9 saturated fatty acid pelargonic acid), bactericides and fungicides (US Pat. Nos. 4,771,571; 5,246,716) and insecticides (e.g., SAFER INSECTICIDAL SOAP by Safer, Inc.).

The phytotoxicity of fatty acids has been a major constraint on their general use in post-plant agricultural applications (US Pat. No. 5,093,124) and the mitigation of these undesirable effects while preserving pesticidal activity is a major area of research. Post-plant applications are desirable because of the relatively short half-life of fatty acids under field conditions.

The esterification of fatty acids can significantly decrease their phytotoxicity (US Pat. Nos. 5,674,897; 5,698,592; 6,124,359). Such modifications can however lead to loss of nematicidal activity as is seen for linoleic, linolenic and oleic acid (Stadler et al. (1994) *Planta Medica* 60(2):128-132) and it may be impossible to completely decouple the phytotoxicity and nematicidal activity of pesticidal fatty acids because of

their non-specific mode of action. Perhaps not surprisingly, the nematicidal fatty acid pelargonic acid methyl ester (US Pat. Nos. 5,674,897; 5,698,592; 6,124,359) shows a relatively small "therapeutic window" between the onset of pesticidal activity and the observation of significant phytotoxicity (Davis et al. (1997) *J Nematol* 29(4S):677-684). This is the expected result if both the phytotoxicity and the nematicidial activity derive from the non-specific disruption of plasma membrane integrity.

Ricinoleic acid, the major component of castor oil, has been shown to have an inhibitory effect on water and electrolyte absorption using everted hamster jejunal and ileal segments (Gaginella et al. (1975) *J Pharmacol Exp Ther* 195(2):355-61) and to be cytotoxic to isolated intestinal epithelial cells (Gaginella et al. (1977) *J Pharmacol Exp Ther* 201(1):259-66). These features are likely the source of the laxative properties of castor oil which is given as a purgative in humans and livestock (e.g., castor oil is a component of some de-worming protocols because of its laxative properties). In contrast, the methyl ester of ricinoleic acid is ineffective at suppressing water absorption in the hamster model (Gaginella et al. (1975) *J Pharmacol Exp Ther* 195(2):355-61).

Many plant species are known to be highly resistant to nematodes. The best documented of these include marigolds (*Tagetes* spp.), rattlebox (*Crotalaria spectabilis*), chrysanthemums (*Chrysanthemum* spp.), castor bean (*Ricinus communis*), margosa (*Azardiracta indica*), and many members of the family *Asteraceae* (family *Compositae*) (Hackney & Dickerson. (1975) *J Nematol* 7(1):84-90). In the case of the *Asteraceae*, the photodynamic compound alpha-terthienyl has been shown to account for the strong nematicidal activity of the roots. Castor beans are plowed under as a green manure before a seed crop is set. However, a significant drawback of the castor plant is that the seed contains toxic compounds (such as ricin) that can kill humans, pets, and livestock and is also highly allergenic. In many cases however, the active principle(s) for plant nematicidal activity has not been discovered and it remains difficult to derive commercially successful nematicidal products from these resistant plants or to transfer the resistance to crops of agronomical importance such as soybeans and cotton.

Genetic resistance to certain nematodes is available in some commercial cultivars (e.g., soybeans), but these are restricted in number and the availability of cultivars with both desirable agronomic features and resistance is limited. The

production of nematode resistant commercial varieties by conventional plant breeding based on genetic recombination through sexual crosses is a slow process and is often further hampered by a lack of appropriate germplasm.

There remains an urgent need to develop environmentally safe, target-specific ways of controlling plant parasitic nematodes. In the specialty crop markets, economic hardship resulting from nematode infestation is highest in strawberries, bananas, and other high value vegetables and fruits. In the high-acreage crop markets, nematode damage is greatest in soybeans and cotton. There are however, dozens of additional crops that suffer from nematode infestation including potato, pepper, onion, citrus, coffee, sugarcane, greenhouse ornamentals and golf course turf grasses.

Nematode parasites of vertebrates (e.g., humans, livestock and companion animals) include gut roundworms, hookworms, pinworms, whipworms, and filarial worms. They can be transmitted in a variety of ways, including by water contamination, skin penetration, biting insects, or by ingestion of contaminated food.

In domesticated animals, nematode control or "de-worming" is essential to the economic viability of livestock producers and is a necessary part of veterinary care of companion animals. Parasitic nematodes cause mortality in animals (e.g., heartworm in dogs and cats) and morbidity as a result of the parasites' inhibiting the ability of the infected animal to absorb nutrients. The parasite-induced nutrient deficiency leads to disease and stunted growth in livestock and companion animals. For instance, in cattle and dairy herds, a single untreated infection with the brown stomach worm can permanently restrict an animal's ability to convert feed into muscle mass or milk.

Two factors contribute to the need for novel anthelmintics and vaccines to control animal parasitic nematodes. First, some of the more prevalent species of parasitic nematodes of livestock are building resistance to the anthelmintic drugs available currently, meaning that these products will eventually lose their efficacy. These developments are not surprising because few effective anthelmintic drugs are available and most have been used continuously. Some parasitic species have developed resistance to most of the anthelmintics (Geents et al. (1997) *Parasitology Today* 13:149-151; Prichard (1994) *Veterinary Parasitology* 54:259-268). The fact that many of the anthelmintic drugs have similar modes of action complicates matters, as the loss of sensitivity of the parasite to one drug is often accompanied by side resistance – that is, resistance to other drugs in the same class (Sangster & Gill (1999)

Parasitology Today 15(4):141-146). Secondly, there are some issues with toxicity for the major compounds currently available.

Infections by parasitic nematode worms result in substantial human mortality and morbidity, especially in tropical regions of Africa, Asia, and the Americas. The World Health Organization estimates 2.9 billion people are infected, and in some areas, 85% of the population carries worms. While mortality is rare in proportion to infections, morbidity is substantial and rivals diabetes and lung cancer in worldwide disability adjusted life year (DALY) measurements.

Examples of human parasitic nematodes include hookworms, filarial worms, and pinworms. Hookworms (1.3 billion infections) are the major cause of anemia in millions of children, resulting in growth retardation and impaired cognitive development. Filarial worms invade the lymphatics, resulting in permanently swollen and deformed limbs (elephantiasis), and the eyes, causing African river blindness. The large gut roundworm *Ascaris lumbricoides* infects more than one billion people worldwide and causes malnutrition and obstructive bowel disease. In developed countries, pinworms are common and often transmitted through children in daycare.

Even in asymptomatic parasitic infections, nematodes can still deprive the host of valuable nutrients and increase the ability of other organisms to establish secondary infections. In some cases, infections can cause debilitating illnesses and can result in anemia, diarrhea, dehydration, loss of appetite, or death.

Despite some advances in drug availability and public health infrastructure and the near elimination of one tropical nematode (the water-borne Guinea worm), most nematode diseases have remained intractable problems. Treatment of hookworm diseases with anthelmintic drugs, for instance, has not provided adequate control in regions of high incidence because rapid re-infection occurs after treatment. In fact, over the last 50 years, while nematode infection rates have fallen in the United States, Europe, and Japan, the overall number of infections worldwide has kept pace with the growing world population. Large scale initiatives by regional governments, the World Health Organization, foundations, and pharmaceutical companies are now underway attempting to control nematode infections with currently available tools, including three programs for control of Onchocerciasis (river blindness) in Africa and the Americas using ivermectin and vector control; The Global Alliance to Eliminate Lymphatic Filariasis using DEC, albendazole, and ivermectin; and the highly successful Guinea

Worm Eradication Program. Until safe and effective vaccines are discovered to prevent parasitic nematode infections, anthelmintic drugs will continue to be used to control and treat nematode parasitic infections in both humans and domestic animals.

Finding effective compounds and vaccines against parasitic nematodes has been complicated by the fact that the parasites have not been amenable to culturing in the laboratory. Parasitic nematodes are often obligate parasites (i.e., they can only survive in their respective hosts, such as in plants, animals, and/or humans) with slow generation times. Thus, they are difficult to grow under artificial conditions, making genetic and molecular experimentation difficult or impossible. To circumvent these limitations, scientists have used *Caenorhabidits elegans* as a model system for parasitic nematode discovery efforts.

C. elegans is a small free-living bacteriovorous nematode that for many years has served as an important model system for multicellular animals (Burglin (1998) *Int. J. Parasitol.* 28(3):395-411). The genome of *C. elegans* has been completely sequenced and the nematode shares many general developmental and basic cellular processes with vertebrates (Ruvkin et al. (1998) *Science* 282:2033-41). This, together with its short generation time and ease of culturing, has made it a model system of choice for higher eukaryotes (Aboobaker et al. (2000) *Ann. Med.* 32:23-30).

Although *C. elegans* serves as a good model system for vertebrates, it is an even better model for study of parasitic nematodes, as *C. elegans* and other nematodes share unique biological processes not found in vertebrates. For example, unlike vertebrates, nematodes produce and use chitin, have gap junctions comprised of innexin rather than connexin and contain glutamate-gated chloride channels rather than glycine-gated chloride channels (Bargmann (1998) *Science* 282:2028-33). The latter property is of particular relevance given that the avermectin class of drugs is thought to act at glutamate-gated chloride receptors and is highly selective for invertebrates (Martin (1997) *Vet. J.* 154:11-34).

A subset of the genes involved in nematode-specific processes will be conserved in nematodes and absent or significantly diverged from homologues in other phyla. In other words, it is expected that at least some of the genes associated with functions unique to nematodes will have restricted phylogenetic distributions. The completion of the *C. elegans* genome project and the growing database of expressed sequence tags (ESTs) from numerous nematodes facilitate identification of these

"nematode-specific" genes. In addition, conserved genes involved in nematode-specific processes are expected to retain the same or very similar functions in different nematodes. This functional equivalence has been demonstrated in some cases by transforming *C. elegans* with homologous genes from other nematodes (Kwa et al. (1995) *J. Mol. Biol.* 246:500-10; Redmond et al. (2001) *Mol. Biochem. Parasitol.* 112:125-131). This sort of data transfer has been shown in cross phyla comparisons for conserved genes and is expected to be more robust among species within a phylum. Consequently, *C. elegans* and other free-living nematode species are likely excellent surrogates for parasitic nematodes with respect to conserved nematode processes.

Many expressed genes in *C. elegans* and certain genes in other free-living nematodes can be "knocked out" genetically by a process referred to as RNA interference (RNAi), a technique that provides a powerful experimental tool for the study of gene function in nematodes (Fire et al. (1998) *Nature* 391(6669):806-811; Montgomery et al. (1998) *Proc. Natl. Acad Sci USA* 95(26):15502-15507). Treatment of a nematode with double-stranded RNA of a selected gene can destroy expressed sequences corresponding to the selected gene thus reducing expression of the corresponding protein. By preventing the translation of specific proteins, their functional significance and contribution to the fitness of the nematode can be assessed. Determination of essential genes and their corresponding proteins using *C. elegans* as a model system will assist in the rational design of anti-parasitic nematode control products.

The phylum apicomplexa contains several important pathogens including *Plasmodium* species (i.e. malaria), *Eimeria* species, *Neospora*, *Babesia*, *Theileria*, *Cryptosporidium* and *Toxoplasma* species.

SUMMARY

Compositions and processes for controlling nematodes, apicomplexa and other pathogens are described herein. In one embodiment, the subject invention comprises the use of certain compounds to control nematodes that infest plants or the situs of plants. Nematodes and apicomplexa that parasitize animals can also be controlled using the methods and compounds of this invention.

Certain of the useful the compounds may be inhibitors of nematode and/or apicomplexa phosphoethanolamine *N*-methyltransferase and related enzymes (also referred to herein as nematode PEAMT enzymes).

Useful compounds include N-substituted ethanolamine analogs such as 2-(diisopropylamino)ethanol, 2-(tert-butylamino)ethanol and N-(2-hydroxyethyl)aniline and C-substituted ethanolamine analogs such as D-phenylalaninol. Useful compounds also include N- or C-substituted derivatives of phosphoethanolamine (phosphate analogs), derivatives of 2-aminoethylphosphonic acid and 3-aminopropylphosphonic acid (phosphonate analogs), and taurine derivatives (sulfonate analogs). Examples of such ethanolamine analogs are 2-amino-3-phenylpropyl phosphonic acid (phosphonate analog) and N-phenyltaurine (sulfonate analog). Among the useful compounds are sulfonate esters, phosphonate diesters and phosphate diesters such as alkyl, phenyl or alkoxyalkyl esters which can be activated to the corresponding sulfonic acid, phosphate or phosphonate compound *in vivo*. Other useful analogs have non-ionizable groups in place of the phosphate moiety. Such compounds include alkyl compounds (e.g., N-ethylaniline, 4-(N-ethyl-N-methylamino)azobenzene, 4-(dimethylamino)azobenzene, 4-(N-methylamino)azobenzene), sulfonyl fluorides (e.g., 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride, 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonyl fluoride), sulfonamides (e.g., 2-(4-phenylazo-phenylamino)-ethanesulfonamide, 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonamide), trifluoromethyl sulfonamides (e.g., C,C,C-Trifluoro-N-(2-phenylamino-ethyl)-methanesulfonamide) and trifluoromethyl sulfones. Certain methylene (CH_2) carbons (e.g., phosphonate) may or may not have their hydrogens substituted, e.g., with fluorine (e.g., fluorinated phosphonate).

Certain embodiments exclude the natural substrates or products of ethanolamine methyltransferases and phosphoethanolamine *N*-methyltransferases such as ethanolamine (EA) or phosphoethanolamine (pEA), monomethylethanolamine (MME) or phosphomonomethylethanolamine (pMME), dimethylethanolamine (DME) or phosphodimethylethanolamine (pDME), choline (Cho) or phosphocholine (pCho) and their corresponding phosphate esters.

Ethanolamine analogs (e.g., alcohols, phosphates, phosphonates, flurophosphonates sulfonates, sulfonyl fluorides, sulfonamides, trifluoromethyl sulfonamides, trifluoromethyl sulfones, phosphate diesters, phosphonate diesters and

sulfonate esters) that have the characteristics of a specific inhibitor of a PEAMT are those analogs that inhibit the activity of a nematode phosphoethanolamine N-methyltransferase to a lesser extent in the presence of products of the methyltransferase reaction (e.g., MME, pMME, DME, pDME, Cho, pCho) than in the presence of substrates of the enzyme (e.g., EA, pEA, MME, pMME, DME, pDME). For these competition experiments the substrate (e.g., pEA) and the product (e.g., pMME) are used in equivalent amounts and the PEAMT inhibitor must not interfere with the uptake of substrates or products of the enzyme. In competition experiments, uncharged precursors to the phosphorylated chemicals such as EA and MME capable of in vivo conversion to the corresponding phosphobases (e.g., pEA or pMME) can also be used. These effects can be demonstrated on a phosphoethanolamine N-methyltransferase (also referred to herein as a PEAMT) protein in vitro, on transgenic cells containing PEAMTs or on intact organisms (e.g., a nematode) containing PEAMT. In one embodiment of this test, the inhibitor, the substrate (or uncharged substrate precursor) and product (or uncharged product precursor) of the PEAMT are present in equal concentrations.

Useful compounds include those that inhibit the expression of a PEAMT at the level of transcription or translation. Other useful compounds impair the modification of a PEAMT resulting in a change in the activity or localization of the methyltransferase.

Some compounds are relatively selective inhibitors of one or more nematode or apicomplexa PEAMT polypeptides relative to one or more plant PEAMT-like polypeptides or plant or animal phosphatidylethanolamine N-methyltransferase polypeptides. The compounds can have a K_i for a nematode PEAMT that is 10-fold, 100-fold, 1,000-fold or more lower than for plant or animal methyltransferase-like polypeptides, e.g., a host plant or host animal of the parasite. Other compounds are relatively non-selective inhibitors or completely non-selective inhibitors.

Also described herein is a method of treating a disorder (e.g., an infection) caused by a nematode, (e.g., *M. incognita, H. glycines, H. contortus, A. suum*) in a subject, e.g., a host plant, animal, or person. In one embodiment the invention features a method of treating a disorder (e.g., an infection) caused by an apicomplexan, (e.g., a *Plasmodium* species, *Eimeria* species, *Neospora*, *Babesia*, *Theileria*, *Cryptosporidium* or *Toxoplasma* species) in a subject, e.g., a host animal, or person. The method

includes administering to the subject an effective amount of a compound having Formula I, II, IIa, IIb, IIc, IId, III, IVa, IVb or IVc . The compound may be delivered by several means including pre-planting, post-planting and as a feed additive, drench, external application, pill or by injection.

In still another aspect, methods of inhibiting a nematode (e.g., *M. incognita, H. glycines, H. contortus, A. suum*) or an apicomplexan (e.g., *P. falciparum*) or other parasite are provided. Such methods can include the steps of: (a) providing a nematode or an apicomplexan or other parasite; (b) contacting the nematode, apicomplexan or other parasite with a compound, e.g., a compound having Formula I, II, IIa, IIb, IIc, IId, III, IVa, IVb or IVc is provided.

In another aspect, methods of reducing the viability or fecundity or slowing the growth or development or inhibiting the infectivity of a nematode or an apicomplexan or other parasite using a pesticidal compound, e.g., a compound having Formula I, II, IIa, IIb, IIc, IId, III, IVa, IVb or IVc is provided. Such methods comprise the steps of (a) providing a nematode or apicomplexan or other parasite; (b) contacting the nematode or apicomplexan or other parasite with specific a compound, e.g., a compound having Formula I, II, IIa, IIb, IIc, IId, III, IVa, IVb or IVc; (c) reducing the viability or fecundity of the nematode or apicomplexan or other parasite.

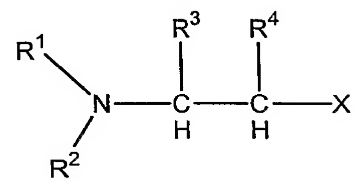
Also described is a method for reducing the viability, growth, or fecundity of a nematode or an apicomplexan or other parasite, the method comprising exposing the nematode or an apicomplexan or other parasite to a compound having Formula I, II, IIa, IIb, IIc, IId, III, IVa, IVb or IVc and a method of protecting a plant from a nematode infection, the method comprising applying to the plant, to the soil, or to seeds of the plant an compound a compound having Formula Formula I, II, IIa, IIb, IIc, IId, III, IVa, IVb or IVc.

Also described is a method for protecting a vertebrate (e.g., a bird or a mammal) from a nematode or apicomplexan infection or other parasite, the method comprising administering to the vertebrate a compound having Formula I, II, IIa, IIb, IIc, IId, III, IVa, IVb or IVc. The bird can be a domesticated fowl (e.g., a chicken, turkey, duck, or goose). The mammal can be a domesticated animal, e.g., a companion animal (e.g., a cat, dog, horse or rabbit) or livestock (e.g., a cow, sheep, pig, goat, alpaca or llama) or can be a human.

The methods described hereon are particularly valuable for the control nematodes attacking the roots of desired crop plants, ornamental plants, and turf grasses. The desired crop plants can be, for example, soybeans, cotton, corn, tobacco, wheat, strawberries, tomatoes, banana, sugar cane, sugar beet, potatoes, or citrus.

Described hereis is a composition, e.g., a pesticidal composition, comprising: an effective amount of a compound or a mixture of compounds having any of the formula described herein, for example the compounds shown below.

Useful compounds include those having Formula (I) or a salt thereof,



Formula (I)

wherein,

R^1 and R^2 are independently selected from H, unsubstituted or substituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), oxo, -COR^7, cyclyl, cyclylalkyl, heterocyclyl, heterocylylalkyl, aryl, arylalkyl, heteroaryl, and heteroarylalkyl; or R^1 and R^2, taken together with the nitrogen to which they are attached, form a heterocyclic ring;

R^3 and R^4 are independently selected from H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl) , aryl, arylalkyl, heteroaryl, and heteroarylalkyl;

X is H, -OH, -$OPO_3(R^5)_2$, -$PO_3(R^5)_2$, -$CH_2PO_3H_2$, -SO_3R^5, -SO_2F, -SO_2NH_2, -SO_2R^5; -CO_2H, -CO_2R^5, -$OC(O)NR^6$, or -OCO_2R^5;

R^5 and R^6 are independently selected from H, substituted or unsubstituted alkyl; (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), or haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl); and

each R^7 is independently H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), hydroxy, or alkoxy.

In some aspects the compound of Formula (I) includes one or more of the following features. Each of R^1 and R^2 can be independently H, alkyl, aryl, or arylalkyl. In some instances, each of R^1 and R^2 can be independently H, methyl, isopropyl,

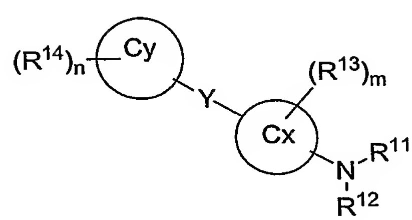
phenyl, or benzyl. Each of R^3 and R^4 can be independently H, alkyl, or arylalkyl. Each of R^3 and R^4 can be independently H. R^3 can be benzyl and R^4 can be H. X can be H, -OH, $-OPO_3H_2$, $-PO_3H_2$, $-CH_2PO_3H_2$, $-SO_3H$, or SO_2F.

In some aspects, each of R^1 and R^2 can be independently H, alkyl, aryl, or arylalkyl; each R^3 and R^4 can be independently H, alkyl, or arylalkyl; and X is H, -OH, $-OPO_3H_2$, $-PO_3H_2$, $-CH_2PO_3H_2$, $-SO_3H$, or SO_2F. For example, each of R^1 and R^2 can be independently H, alkyl, aryl, or arylalkyl. Each of R^1 and R^2 can be independently H, methyl, isopropyl, phenyl, or benzyl. Each of R^3 and R^4 can be independently H. R^3 can be benzyl and R^4 can be H.

In some aspects, the compound of Formula (I) is one of 2-Amino-ethanol, 2-Methylamino-ethanol, 2-Dimethylamino-ethanol, choline chloride, phosphoric acid mono-(2-amino-ethyl) ester, 2-Amino-ethanesulfonic acid, (3-Amino-propyl)-phosphonic acid, 2-Diisopropylamino-ethanol, 2-tert-Butylamino-ethanol, 2-Amino-3-phenyl-propan-1-ol, 2-Phenylamino-ethanol, 2-Phenylamino-ethanesulfonic acid, 2-Amino-1-phenyl-ethanol, 2-Benzylamino-ethanol, or 2-Diisopropylamino-ethanesulfonyl fluoride.

In some aspects, the compound of Formula (I) has a molecular weight of less than 500 Daltons. In some aspects, the compound of Formula (I) includes at least one I or Br.

Useful compounds also include a compound of Formula (IIa) or a salt thereof,



Formula (IIa)

wherein,

R^{11} and R^{12} are independently selected from H, hydroxy, oxo, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), sulfonyl, aminosulfonylalkyl, halosulfonylalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl) or $C(O)R^{17}$; or R^{11} and R^{12}, together with the nitrogen to which they are attached, form a heterocyclyl or heteroaryl ring; or one of R^{11} or R^{12}, together with R^{13}

and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring; each R^{11} and R^{12} can optionally be independently be substituted by one or more R^{15};

each R^{13} is independently halo, $C(O)R^{17}$, hydroxy, alkoxy, sulfonyl, aminohaloalkyl, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl) or haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl); each of which is optionally independently substituted with 1-4 R^{16};

each R^{14} is independently halo, $C(O)R^{17}$, hydroxy, alkoxy, amino, sulfonyl, aminohaloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 aminohaloalkyl), substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), nitro, aryl, heteroaryl, cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{16};

each m and n is independently 0-4 (e.g., 1, 2, 3 or 4);

each R^{15} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), C(O), or C(S);

each R^{16} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), or $C(O)R^{17}$;

Cx is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Y is -N=N-, $-C(R^{17})=C(R^{17})-$, $-C(O)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(O)-$, $-C(OH)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(OH)-$, $-CH_2CH_2-$, -C≡C-, -CH(OH)-, $-CH_2-$, -C(O)-, $-C(O)CH_2-$, $-CH_2C(O)-$, -C(O)CH(OH)-, -CH(OH)C(O)-, $-CH_2N(R^{18})-$, $-N(R^{18})CH_2-$, $-CH_2N(R^{18})CH_2-$, $-CH_2CH_2N(R^{18})-$, $-N(R^{18})CH_2CH_2-$, $-CH_2OCH_2-$, $-CH_2CH_2O-$, $-OCH_2CH_2-$, $-CH_2S(O)_qCH_2-$, $-CH_2CH_2S(O)_q-$, $-S(O)_qCH_2CH_2-$, $-C(O)N(R^{18})-$, $-N(R^{18})C(O)-$, $-N(R^{18})C(O)N(R^{18})-$, $-N(R^{18})C(S)-N(R^{18})-$, $-CH(OH)CH_2-$, $-CH_2CH(OH)-$, -CH=CH-, $-S(O)_qN(R^{18})-$, $-C(O)N(R^{18})C(R^{17})_2$, $-C(O)CH_2CH_2-$, -C(O)C(O)-, -C(C)-, -S(O)-, -, $S(O)_qN(R^{18})C(R^{17})_2$, $-C(O)CH_2C(R^{17})-$, $-CH_2C(O)C(R^{17})-$, $-CHCHS(O)_q-$, $NR^{18}-$, or $–C(O)C(R^{17})C(R^{17})-$;

q is 0, 1, or 2;

each R^{17} is independently H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy, or alkoxy (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkoxy); and

each R^{18} is independently H or substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl).

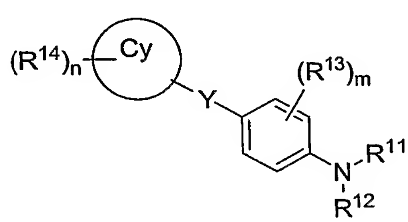
In some aspects the compound of formula (IIa) can include one or more of the following features. Cx or Cy can be pyridyl. Cx or Cy can be phenyl. Cx can be phenyl and Cy can be phenyl or pyridyl. In some instances Cx is phenyl and $NR^{11}R^{12}$ is positioned para to Y. In some instances, R^{11} is H, alkyl, or oxo; or when taken together with R^{12} and the nitrogen to which it is attached, forms a heterocyclyl or heteroaryl ring; or when taken together with R^{13} and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring; and R^{12} is H, alkyl, hydroxy, halosulfonylalkyl, -C(O)R^{17}, or when taken together with R^{12} and the nitrogen to which it is attached, forms a heterocyclyl or heteroaryl ring; or when taken together with R^{13} and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring. For example, R^{11} can be H and R^{12} can be fluorosulfonylalkyl. R^{12} can be flourosulfonylethyl. R^{12} can be -C(O)CH_3. R^{11} taken together with R^{12} and the nitrogen to which they are attached can form a heterocyclyl. R^{11} taken together with R^{13} and the nitrogen to which it is attached can form a heterocyclyl. R^{11} and R^{12}, together with the nitrogen to which they are attached can be nitro. Each R^{11} and R^{12} can independently be H or alkyl or haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl). For example, R^{11} can be H and R^{12} can be methyl or ethyl or trifluoromethyl. R^{11} and R^{12} can both be alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl) or haloalkyl, (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl) for example, R^{11} can be methyl or ethyl or trifluoromethyl and R^{12} can be methyl or ethyl or trifluoromethyl. In some instances, m is 0. In some instances, m is 1; and R^{13} is alkyl, hydroxy, halo, for example, R^{13} is methyl, hydroxy, or chloro. In some instances, n is 0. In some instances, n is 1; and R^{14} is halo, alkyl, hydroxy, alkoxy, amino, or nitro. In some instances, Y is -N=N-, -CR^{17}=CR^{17}- (e.g., -CH=CH-), -C(O)CR^{17}=CR^{17}- (e.g., -C(O)CH=CH-), -CR^{17}=CR^{17}C(O)- (e.g., -CHCHC(O)-), -C(OH)CR^{17}=CR^{17}-, -CR^{17}=CR^{17}C(OH)-, -CH(OH)-, or -C(O)-, for example, Y is -N=N-, or -CR^{17}=CR^{17}-.

Specific examples of R^{13} include: COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

Specific examples of R^{14} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$

In some aspects, R^{11} is H, alkyl, or fluoroalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 fluoroalkyl); R^{12} is H, alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), or fluoroalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 fluoroalkyl), R^{13} is alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), hydroxy, fluoroalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 fluoroalkyl), aminofluoroalkyl, sulfonyl, or halo; R^{14} is halo, alkyl, fluoroalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 fluoroalkyl), aminofluoroalkyl, sulfonyl, hydroxy, alkoxy (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkoxy), amino, or nitro; m and n are each independently 0 or 1; and Y is -N=N-, -CR^{17}=CR^{17}- (e.g.,-CH=CH-), -C(O)CR^{17}=CR^{17}- (e.g., -C(O)CHCH-), -CR^{17}=CR^{17}C(O)- (e.g., -CH=CHC(O)-), -C(OH)CR^{17}=CR^{17}-, -CR^{17}=CR^{17}C(OH)-, -CH(OH)-, or -C(O)-.

Also useful are compounds of Formula (IIb) or a salt thereof



Formula (IIb)

wherein,

R^{11} and R^{12} are independently selected from H, hydroxy, oxo, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), sulfonyl, aminosulfonylalkyl, halosulfonylalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), or C(O)R^{17}; or R^{11} and R^{12}, together with the nitrogen to which they are attached, form a heterocyclyl or heteroaryl ring; or one of R^{11} or R^{12}, together with R^{13} and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring; each R^{11} and R^{12} can independently be substituted by one or more R^{15} (e.g., 1-4 R^{15});

each R^{13} is independently halo, C(O)R^{17}, hydroxy, alkoxy, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), or sulfonyl; each of which is optionally substituted with 1-4 R^{16};

each R^{14} is independently halo, $C(O)R^{17}$, hydroxy, alkoxy, amino, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), sulfonyl, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), nitro, aryl, heteroaryl, cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{16};

m and n are independently 0-4;

each R^{15} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), C(O), or C(S);

each R^{16} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), or $C(O)R^{17}$;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Y is -N=N-, $-C(R^{17})=C(R^{17})-$, $-C(O)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(O)-$, $-C(OH)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(OH)-$, $-CH_2CH_2-$, -C≡C-, -CH(OH)-, $-CH_2-$, -C(O)-, $-C(O)CH_2-$, $-CH_2C(O)-$, -C(O)CH(OH)-, -CH(OH)C(O)-, $-CH_2N(R^{18})-$, $-N(R^{18})CH_2-$, $-CH_2N(R^{18})CH_2-$, $-CH_2CH_2N(R^{18})-$, $-N(R^{18})CH_2CH_2-$, $-CH_2OCH_2-$, $-CH_2CH_2O-$, $-OCH_2CH_2-$, $-CH_2S(O)_qCH_2-$, $-CH_2CH_2S(O)_q-$, $-S(O)_qCH_2CH_2-$, $-C(O)N(R^{18})-$, $-N(R^{18})C(O)-$, $-N(R^{18})C(O)N(R^{18})-$, $-N(R^{18})C(S)-N(R^{18})-$, $-CH(OH)CH_2-$, $-CH_2CH(OH)-$, -CH=CH-, $-S(O)_qN(R^{18})-$, $-C(O)N(R^{18})C(R^{17})_2$, $-C(O)CH_2CH_2-$, -C(O)C(O)-, -C(C)-, -S(O)-, -, $S(O)_qN(R^{18})C(R^{17})_2$, $-C(O)CH_2C(R^{17})-$, $-CH_2C(O)C(R^{17})-$, $-CHCHS(O)_q-$, $NR^{18}-$, or $-C(O)C(R^{17})C(R^{17})-$;

q is 0, 1, or 2;

each R^{17} is independently H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy, or alkoxy (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkoxy); and

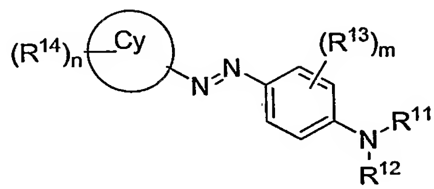
each R^{18} is independently H or substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl).

In some aspects, Cy is phenyl or pyridyl. In some aspects, R^{11} and R^{12} are CF_3.

Specific examples of R^{13} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$.

Specific examples of R^{14} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$.

Also useful are compounds of Formula (IIc) or a salt thereof,



Formula (IIc)

wherein,

R^{11} and R^{12} are independently selected from H, hydroxy, oxo, substituted or unsubstituted alkyl (e.g., C_1 to C_{10}, or C_1 to C_5 or C_1 to C_3 alkyl or methyl), sulfonyl, aminosulfonylalkyl, halosulfonylalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), or -C(O)R^{17}; or R^{11} and R^{12}, together with the nitrogen to which they are attached, form a heterocyclyl or heteroaryl ring; or one of R^{11} or R^{12}, together with R^{13} and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring; each R^{11} and R^{12} can independently be substituted by one or more R^{15};

each R^{13} is independently halo, C(O)R^{17}, hydroxy, alkoxy (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkoxy), substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), sulfonyl, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl); each of which is optionally substituted with 1-4 R^{16}; R^{14} is halo, C(O)R^{17}, hydroxy, alkoxy (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkoxy), amino, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), sulfonyl, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), nitro, aryl, heteroaryl, cyclyl, heterocyclyl; each of which is optionally substituted with 1-4 R^{16}; m and n are independently 0-4;

each R^{15} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), C(O), C(S);

each R^{16} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl);

each R^{17} is H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy, or alkoxy (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkoxy); and

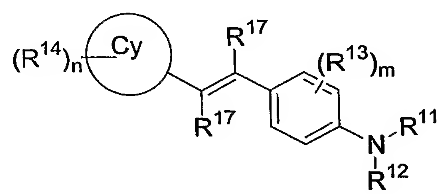
Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl.

In some aspects, Cy is phenyl or pyridyl, for example Cy is phenyl. In some aspects, R^{11} and R^{12} are CF_3.

Specific examples of R^{13} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$.

Specific examples of R^{14} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$.

Useful compound also include a compound of Formula (IId) or a salt thereof,



Formula (IId)

wherein,

R^{11} and R^{12} are independently selected from H, hydroxy, oxo, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), sulfonyl, aminosulfonylalkyl, halosulfonylalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), $C(O)R^{17}$ or R^{11} and R^{12}, together with the nitrogen to which they are attached, form a heterocyclyl or heteroaryl ring; or one of R^{11} or R^{12}, together with R^{13} and the nitrogen to which is it attached, form a heterocycleyl or heteroaryl ring; each R^{11} and R^{12} can independently be substituted by one or more R^{15};

each R^{13} is independently halo, $C(O)R^{17}$, hydroxy, alkoxy, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), sulfonyl, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl) ; each of which is optionally substituted with 1-4 R^{16}; specific examples of R^{13} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$;

each R^{14} is independently halo, $C(O)R^{17}$, hydroxy, alkoxy, amino, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), sulfonyl, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), nitro, aryl,

heteroaryl, cyclyl, heterocyclyl; each of which is optionally substituted with 1-4 R^{16}; specific examples of R^{14} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$;

each m and n are independently 0-4;

each R^{15} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), C(O), C(S);

each R^{16} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl);

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl; and

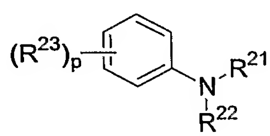
each R^{17} is independently H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy, or alkoxy.

In one aspect, Cy is phenyl or pyridyl, for example, phenyl. In another aspect, R^{11} and R^{12} are CF_3.

In one aspect, the invention includes one of the following compounds: Ethyl-methyl-(4-phenylazo-phenyl)-amine, 2-[4-(4-Dimethylamino-phenylazo)-phenylamino]-ethanesulfonyl fluoride, 2-(4-Phenylazo-phenylamino)-ethanesulfonic acid amide, 2-(4-Phenylazo-phenylamino)-ethanesulfonyl fluoride, Dimethyl-(4-phenylazo-phenyl)-amine, Dimethyl-(3-methyl-4-phenylazo-phenyl)-amine, [4-(4-Bromo-phenylazo)-phenyl]-ethyl-amine, Ethyl-(4-p-tolylazo-phenyl)-amine, Dimethyl-(4-p-tolylazo-phenyl)-amine, 1-(4-Phenylazo-phenyl)-pyrrole-2,5-dione, N-(2-Chloro-4-phenylazo-phenyl)-acetamide, (4-Bromo-phenyl)-(1-methyl-1,2,3,4-tetrahydro-quinolin-6-yl)-diazene, (4-Methoxy-phenyl)-(1-methyl-1,2,3,4-tetrahydro-quinolin-6-yl)-diazene, 5-Dimethylamino-2-(pyridin-2-ylazo)-phenol, Dimethyl-(4-o-tolylazo-phenyl)-amine, Methyl-(4-phenylazo-phenyl)-amine, 4-(4-Nitro-phenylazo)-phenol, [4-(3-Chloro-phenylazo)-phenyl]-dimethyl-amine, Dimethyl-[4-(pyridin-2-ylazo)-phenyl]-amine, [4-(4-methylamino-phenylazo)-phenyl]-dimethyl-amine, 3-[4-(4-Nitro-phenylazo)-phenyl]-2-thioxo-thiazolidin-4-one, (4-Nitro-phenyl)-phenyl-diazene, 3-(4-Dimethylamino-phenyl)-1-phenyl-propenone, (4-Dimethylamino-phenyl)-phenyl-methanone, Bis-(4-methylamino-phenyl)-methanone, [4-(4-Methoxy-phenylazo)-phenyl]-dimethyl-amine, 6-(4-Dimethylamino-phenylazo)-phenylamine, [4-(4-Fluoro-

phenylazo)-phenyl]-dimethyl-amine, [4-(4-Bromo-phenylazo)-phenyl]-dimethyl-amine, Dimethyl-[4-(4-nitro-phenylazo)-phenyl]-amine, Methyl-(4-m-tolylazo-phenyl)-amine, Bis-(4-dimethylamino-phenyl)-methanol, Bis-(4-dimethylamino-phenyl)-methane, Dimethyl-(4-styryl-phenyl)-amine, Dimethyl-(4-phenylaminomethyl-phenyl)-amine, 1-(4-Dimethylamino-phenyl)-2-hydroxy-2-phenyl-ethanone, N-(4-Dimethylamino-phenyl)-benzamide, 1-(4-Dimethylamino-phenyl)-2-phenyl-ethanone, 1-(4-Dimethylamino-phenyl)-2-phenyl-ethanol, 1-(4-Dimethylamino-phenyl)-3-phenyl-thiourea, 1-(4-Dimethylamino-phenyl)-3-phenyl-urea, or [4-(Benzylamino-methyl)-phenyl]-dimethyl-amine.

Also useful are compounds of Formula (III) or a salt thereof,



Formula (III)

wherein,

R^{21} and R^{22} are independently selected from H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), $C(O)R^{26}$, $S(O)_2R^{27}$, PO_3H_2, aryl, or arylalkyl; each of which is optionally substituted with 1-4 R^{24}; or R^{21} and R^{22}, together with the nitrogen to which they are attached, form a heterocyclyl, which is optionally substituted with 1-4 R^{24};

each R^{23} is independently nitro, nitroso, amino, halo, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy, alkoxy, $NR^{28}C(O)R^{26}$, $C(O)R^{26}NR^{28}R^{29}$, aryl, heteroaryl, or heterocyclyl, each of which is optionally substituted with 1-4 R^{25};

each R^{24} is independently halo, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl),

each R^{25} is independently halo, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy, alkoxy, nitro, cyano;

each R^{26} is independently hydroxy, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), or alkoxy;

each R^{27} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy or alkoxy;

each R^{28} is independently H or substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl);

each R^{29} is independently H or substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl) ; and

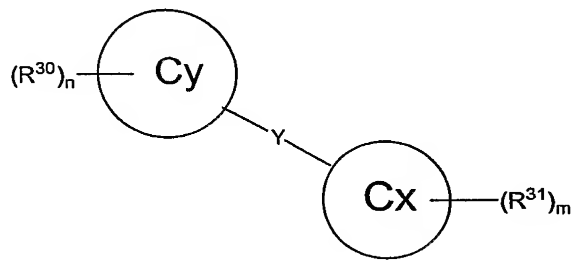
p is 0-4.

In some aspects, the compound of Formula (III) includes one or more of the following features. Each R^{21} and R^{22} can be independently H or alkyl, for example, R^{21} can be H and R^{22} can be alkyl; R^{21} can be H and R^{22} can be ethyl; or R^{22} can be methyl or ethyl. In some instances, p is 1 or 2. Each R^{23} can be independently halo, alkyl, hydroxy, alkoxy, nitro, nitroso, or amino. In some aspects, each R^{21} and R^{22} is H or alkyl; each R^{23} is independently halo, alkyl, hydroxy, alkoxy, nitro, nitroso, or amino; and p is 0-2. In some instances, each R^{21} and R^{22} is H, methyl, or ethyl. In some instances, the compound of Formula (III) has a molecular weight of less than 500 Daltons. In some instances, the compound of Formula (III) includes at least one I or Br.

In some embodiments, the compound of Formula (III) is one of the following compounds: 2-Phenylamino-ethanesulfonyl fluoride, N-ethylaniline, Methyl-phenyl-amine, Dimethyl-phenyl-amine, N,N,N',N'-Tetramethyl-benzene-1,4-diamine, Methyl-(4-nitro-phenyl)-amine, Ethyl-(4-nitro-phenyl)-amine, Methyl-(2-nitro-phenyl)-amine, Dimethyl-(4-nitro-phenyl)-amine, (2-Chloro-4-nitro-phenyl)-dimethyl-amine, (2-Chloro-phenyl)-dimethyl-amine, Ethyl-(2-methyl-5-nitro-phenyl)-amine, N1-Methyl-4-nitro-benzene-1,2-diamine, N1-Ethyl-4-nitro-benzene-1,2-diamine, (2,4-Dinitro-phenyl)-methyl-amine, (2,4-Dinitro-phenyl)-ethyl-amine, Methyl-(4-nitroso-phenyl)-amine, N,N-Dimethyl-benzene-1,4-diamine, (4-Methoxy-phenyl)-methyl-amine, N-Methyl-benzene-1,2-diamine, (2-Bromo-4-methyl-phenyl)-ethyl-amine, Methyl-o-tolyl-amine, Dimethyl-o-tolyl-amine, Dimethyl-m-tolyl-amine, Dimethyl-p-tolyl-amine, Ethyl-o-tolyl-amine, Ethyl-m-tolyl-amine, (2-Chloro-phenyl)-methyl-amine, (4-Chloro-phenyl)-methyl-amine, (4-Chloro-phenyl)-ethyl-amine, 3-Dimethylamino-

phenol, 3-Ethylamino-4-methyl-phenol, 4-Methylamino-phenol, [4-(2,3-Dihydro-benzothiazol-2-yl)-phenyl]-dimethyl-amine, [4-(2,3-Dihydro-benzooxazol-2-yl)-phenyl]-dimethyl-amine, or [4-(1,3-Dimethyl-2,3-dihydro-1H-benzoimidazol-2-yl)-phenyl]-dimethyl-amine.

Also useful are compounds having Formula (IVa) and salts thereof.



Formula (IVa)

wherein,

each R^{30} is independently hydrogen, $C(O)R^{33}$, halo, hydroxy, alkoxy, amino, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), sulfonyl, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), nitro, aryl, heteroaryl or cyclyl; each of which is optionally substituted with 1-4 R^{32}; specific examples of R^{30} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$;

each R^{31} is independently hydrogen, $C(O)R^{33}$, halo, hydroxy, alkoxy, amino, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), sulfonyl, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), nitro, aryl, heteroaryl or cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{32}; specific examples of R^{31} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$;

m and n are independently 0-4;

each R^{32} is independently halogen, -OH, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), or $C(O)R^{33}$;

Cx is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl

Y is -N=N-, -C(R^{17})=C(R^{17})-, -C(O)C(R^{17})=C(R^{17})-, -C(R^{17})=C(R^{17})C(O)-, -C(OH)C(R^{17})=C(R^{17})-, -C(R^{17})=C(R^{17})C(OH)-, -CH_2CH_2-, -C≡C-, -CH(OH)-, -CH_2-, -C(O)-, -C(O)CH_2-, -CH_2C(O)-, -C(O)CH(OH)-, -CH(OH)C(O)-, -CH_2N(R^{18})-, -N(R^{18})CH_2-, -CH_2N(R^{18})CH_2-, -CH_2CH_2N(R^{18})-, -N(R^{18})CH_2CH_2-, -CH_2OCH_2-, -CH_2CH_2O-, -OCH_2CH_2-, -$CH_2S(O)_qCH_2$-, -$CH_2CH_2S(O)_q$-, -$S(O)_qCH_2CH_2$-, -C(O)N(R^{18})-, -N(R^{18})C(O)-, -N(R^{18})C(O)N(R^{18})-, -N(R^{18})C(S)-N(R^{18})-, -CH(OH)CH_2-, -CH_2CH(OH)-, -CH=CH-, -$S(O)_q$N(R^{18})-, -C(O)N(R^{18})C(R^{17})$_2$, -C(O)CH_2CH_2-, -C(O)C(O)-, -C(C)-, -S(O)-, -, $S(O)_q$N(R^{18})C(R^{17})$_2$, -C(O)CH_2C(R^{17})-, -CH_2C(O)C(R^{17})-, -CHCHS$(O)_q$-, NR^{18}-, or –C(O)C(R^{17})C(R^{17})- ;

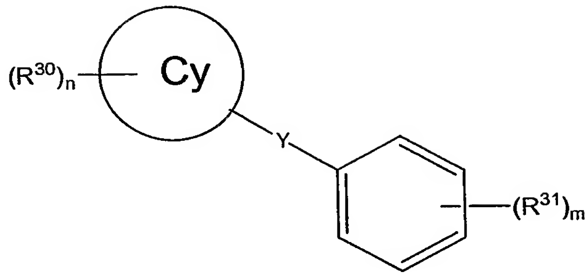
q is 0, 1, or 2;

each R^{33} is independently H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy, or alkoxy; and

each R^{34} is independently H or substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), provided that when Cy and Cx are benzyl and Y is -C(O)CH=CH-, m and n are not both 0.

In some aspects the compound of Formula (IVa) can include one or more of the following features. Cx or Cy can be pyridyl. Cx or Cy can be phenyl. Cx can be phenyl and Cy can be phenyl or pyridyl. Both Cx and Cy are phenyl. In some instances Cx is phenyl, n is 1, and C^{30} is positioned para to Y. In some instances both Cx and Cy are phenyl, both n and m are 1, and both C30 and C^{31} are positioned para to Y. In some instances, m is 1; and R^{31} is substituted or unsubstituted alkyl, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, halo, for example, R^{31} is methyl, N(CF_3)$_2$, trifluoromethyl, sulfonamide, hydroxy, or chloro. In some instances, n is 0. In some instances, n is 1; and R^{30} is halo, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, or nitro. In some instances, Y is -N=N-, -CR^{33}=CR^{33}- (e.g., -CH=CH-), -C(O)CR^{33}=CR^{33}- (e.g, -C(O)CH=CH-), -CR^{33}=CR^{33}C(O)- (e.g., -CHCHC(O)-), -C(OH)CR^{33}=CR^{33}-, -CR^{33}=CR^{33}C(OH)-, -CH(OH)-, or -C(O)-, for example, Y is -N=N-, or –CR^{33}=CR^{33}-.

Useful compounds include those having Formula (IVb) and salts thereof.



Formula (IVb)

wherein

each R^{30} is independently hydrogen, $C(O)R^{33}$, halo, hydroxy, alkoxy, amino, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), sulfonyl, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), nitro, aryl, heteroaryl, cyclyl; each of which is optionally substituted with 1-4 R^{32}; specific examples of R^{30} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$;

each R^{31} is independently hydrogen, $C(O)R^{33}$, halo, hydroxy, alkoxy, amino, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), sulfonyl, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), nitro, aryl, heteroaryl, cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{32}; specific examples of R^{31} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$;

each m and n is independently 0-4;

each R^{32} is independently halogen, -OH, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), or $C(O)R^{33}$;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Y is -N=N-, $-C(R^{17})=C(R^{17})-$, $-C(O)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(O)-$, $-C(OH)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(OH)-$, $-CH_2CH_2-$, -C≡C-, -CH(OH)-, $-CH_2-$, -C(O)-, $-C(O)CH_2-$, $-CH_2C(O)-$, -C(O)CH(OH)-, -CH(OH)C(O)-, $-CH_2N(R^{18})-$, $-N(R^{18})CH_2-$, $-CH_2N(R^{18})CH_2-$, $-CH_2CH_2N(R^{18})-$, $-N(R^{18})CH_2CH_2-$, $-CH_2OCH_2-$, $-CH_2CH_2O-$, $-OCH_2CH_2-$, $-CH_2S(O)_qCH_2-$, $-CH_2CH_2S(O)_q-$, $-S(O)_qCH_2CH_2-$, $-C(O)N(R^{18})-$, $-N(R^{18})C(O)-$, $-N(R^{18})C(O)N(R^{18})-$, $-N(R^{18})C(S)-N(R^{18})-$, $-CH(OH)CH_2-$, $-CH_2CH(OH)-$, -CH=CH-, $-S(O)_qN(R^{18})-$, $-C(O)N(R^{18})C(R^{17})_2$, $-C(O)CH_2CH_2-$, -

C(O)C(O)-, -C(C)-, -S(O)-, -, S(O)$_q$N(R^{18})C(R^{17})$_2$, -C(O)CH_2C(R^{17})-, -CH_2C(O)C(R^{17})-, -CHCHS(O)$_q$-, NR^{18}-, or –C(O)C(R^{17})C(R^{17})- ;

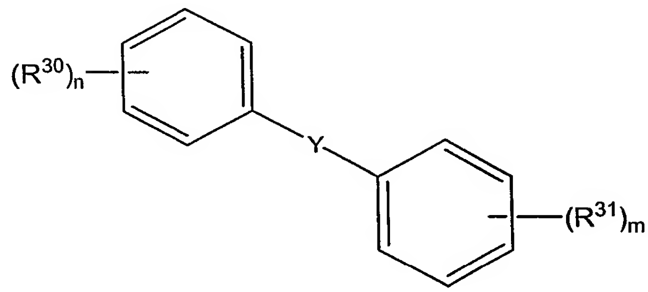
q is 0, 1, or 2;

each R^{33} is independently H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy, or alkoxy; and

each R^{34} is independently H or substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), provided that when Cy is benzyl and Y is -C(O)CH=CH-, m and n are not both 0.

In some aspects the compound of Formula (IVb) can include one or more of the following features. Cy can be phenyl or pyridyl. Cy can phenyl. In some instances, n is 1, and C^{30} is positioned para to Y. In some instances Cy is phenyl, both n and m are 1, and both C^{30} and C^{31} are positioned para to Y. In some instances, m is 1; and R^{31} is alkyl, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, halo, for example, R^{31} is methyl, trifluoromethyl, N(CF_3)$_2$, sulfonamide, hydroxy, or chloro. In some instances, n is 0. In some instances, n is 1; and R^{30} is halo, haloalkyl, alkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, or nitro. In some instances, Y is -N=N-, -CR^{33}=CR^{33}- (e.g., -CH=CH-), -C(O)CR^{33}=CR^{33}- (e.g., -CH=CHC(O)-), -CR^{33}=CR^{33}C(O)- (e.g., CH=CHC(O)-), -C(OH)CR^{33}=CR^{33}-, -CR^{33}=CR^{33}C(OH)-, -CH(OH)-, or -C(O)-, for example, Y is -N=N-, or –CR^{33}=CR^{33}-.

Useful compounds include those having Formula (IVc) and salts thereof.



Formula (IVc)

Wherein:

each R^{30} is independently hydrogen, $C(O)R^{33}$, halo, hydroxy, alkoxy, amino, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), sulfonyl, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), nitro, aryl, heteroaryl, cyclyl; each of which is optionally independently substituted with 1-4 R^{32}; specific examples of R^{30} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$;

each R^{31} is independently hydrogen, $C(O)R^{33}$, halo, hydroxy, alkoxy, amino, aminohaloalkyl, haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), sulfonyl, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), nitro, aryl, heteroaryl, cyclyl, or heterocyclyl; each of which is optionally independently substituted with 1-4 R^{32}; specific examples of R^{31} include COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$;

each m and n is independently 0-4;

each R^{32} is independently substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl) or $-C(O)R^{33}$;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Y is -N=N-, $-C(R^{17})=C(R^{17})-$, $-C(O)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(O)-$, $-C(OH)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(OH)-$, $-CH_2CH_2-$, -C≡C-, -CH(OH)-, $-CH_2-$, -C(O)-, $-C(O)CH_2-$, $-CH_2C(O)-$, -C(O)CH(OH)-, -CH(OH)C(O)-, $-CH_2N(R^{18})-$, $-N(R^{18})CH_2-$, $-CH_2N(R^{18})CH_2-$, $-CH_2CH_2N(R^{18})-$, $-N(R^{18})CH_2CH_2-$, $-CH_2OCH_2-$, -

CH_2CH_2O-, -OCH_2CH_2-, -$CH_2S(O)_qCH_2$-, -$CH_2CH_2S(O)_q$-, -$S(O)_qCH_2CH_2$-, -C(O)N(R^{18})-, -N(R^{18})C(O)-, -N(R^{18})C(O)N(R^{18})-, -N(R^{18})C(S)-N(R^{18})-, -CH(OH)CH_2-, -CH_2CH(OH)-, -CH=CH-, -$S(O)_q$N(R^{18})-, -C(O)N(R^{18})C(R^{17})$_2$, -C(O)CH_2CH_2-, -C(O)C(O)-, -C(C)-, -S(O)-, -, $S(O)_q$N(R^{18})C(R^{17})$_2$, -C(O)CH_2C(R^{17})-, -CH_2C(O)C(R^{17})-, -CHCHS$(O)_q$-, NR^{18}-, or –C(O)C(R^{17})C(R^{17})- ;

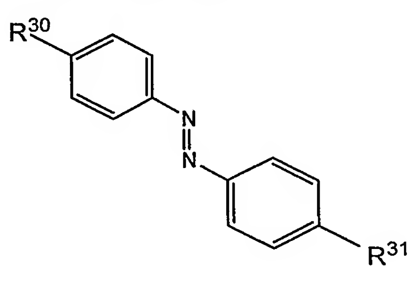
q is 0, 1, or 2;

each R^{33} is independently H, substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), haloalkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 haloalkyl), hydroxy, or alkoxy; and

each R^{34} is independently H or substituted or unsubstituted alkyl (e.g., C_1 to C_{10} or C_1 to C_5 or C_1 to C_3 alkyl), provided that provided that when Y is -C(O)CH=CH-, m and n are not both 0.

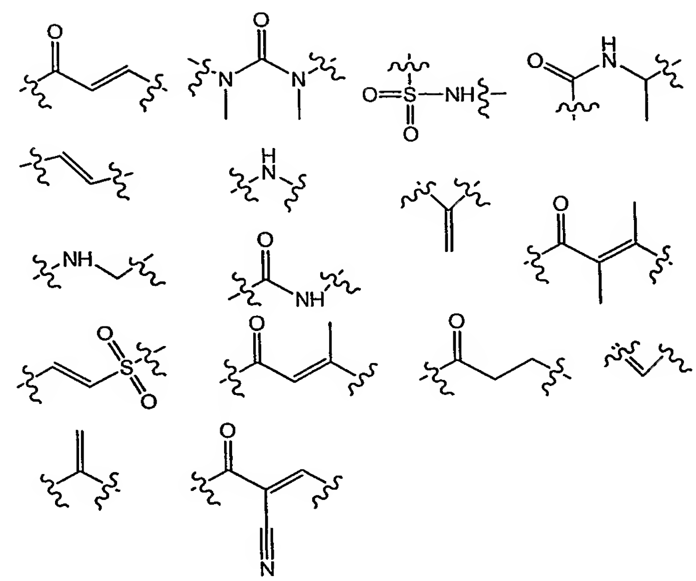
In some aspects the compound of Formula (IVc) can include one or more of the following features. In some instances, n is 1, and C^{30} is positioned para to Y. In some instances, both n and m are 1, and both C^{30} and C^{31} are positioned para to Y. In some instances, m is 1; and R^{31} is substituted or unsubstituted alkyl, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, halo, for example, R^{31} is methyl, trifluoromethyl, $N(CH_3)_2$, sulfonamide, hydroxy, or chloro. In some instances, n is 0. In some instances, n is 1; and R^{30} is halo, haloalkyl, alkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, or nitro. In some instances, Y is -N=N-, -CR^{33}=CR^{33}-, -C(O)CR^{33}=CR^{33}-, -CR^{33}=CR^{33}C(O)-, -C(OH)CR^{33}=CR^{33}-, -CR^{33}=CR^{33}C(OH)-, -CH(OH)-, or -C(O)-, for example, Y is -N=N-, or –CR^{33}=CR^{33}-.

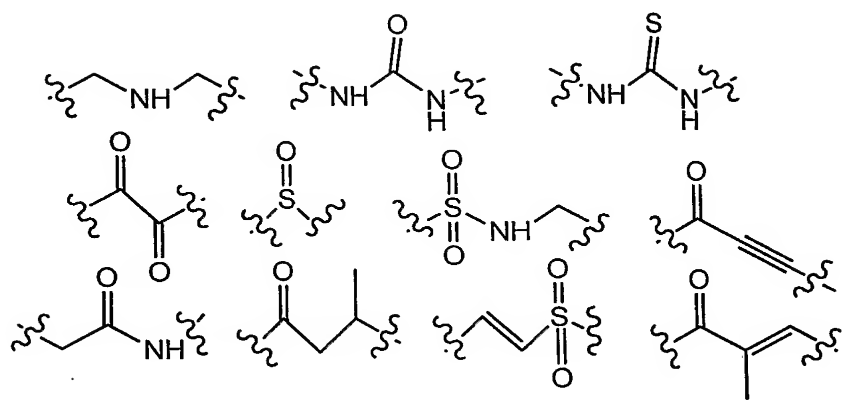
In some cases where a compound having Formula (IVc) has the structure:



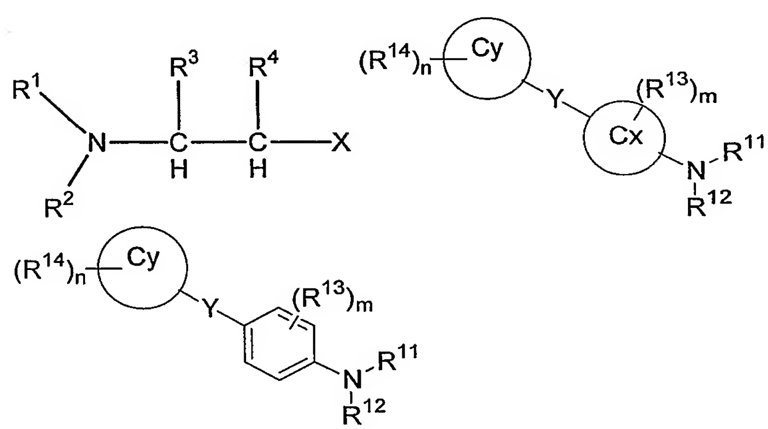
, R^{30} and R^{31} are not Cl, Br, Fl, -OH, -CH_3 or -OCH_3.

For Formulas IIa, IIb, IVa, IVb and IVc, specific examples of Y include:

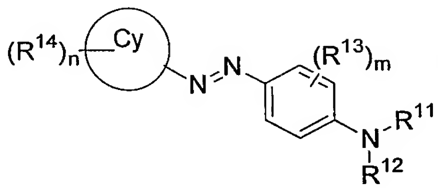
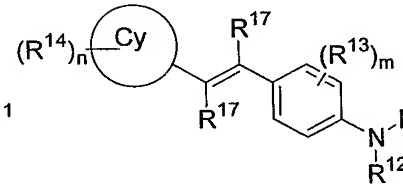
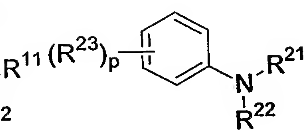




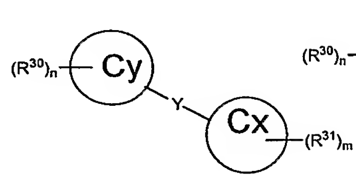
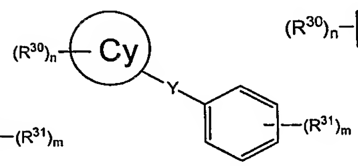
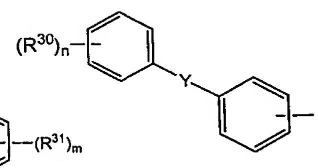
A pesticidal composition including an effective amount of any of the formulae described herein is described, for example one of the following formulas:



Formula (I) Formula (IIa) Formula (IIb)

Formula (IIc) Formula (IId) Formula (III)

Formula (IVa) Formula (IVb) Formula (IVc)

In some aspects, the pesticidal composition further includes an aqueous surfactant. In some apsects, the pesticidal composition further includes a permeation enhancer. In some aspects, the pesticidal composition further includes a co-solvent. In some aspects, the pesticidal composition further includes a pesticide (e.g., insecticide or fungicide) such as avermectins (e.g., ivermectin), milbemycin, aldicarb, oxamyl, fenamiphos, fosthiazate, metam sodium, etridiazole, penta-chloro-nitrobenzene (PCNB), flutolanil, metalaxyl, mefonoxam, and fosetyl-al. Useful fungicides include, but are not limited to, myclobutanil, azoxystrobin,. chlorothalonil, propiconazole, tebuconazole and pyraclostrobin

Also described is a method for control of unwanted nematodes or apicomplexan parasites, the method including administering to vertebrates, plants, seeds or soil a pesticidal composition including a compound of any of the formulae described herein in any of the pesticidal compositions described herein.

In some aspects, the method features one or more of the following features. In some instances, the nematode infects plants and the pesticidal composition is applied to the soil or to plants. In some instances, the pesticidal composition is applied to soil before planting. In some instances, the pesticidal composition is applied to soil after

planting. In some instances, the pesticidal composition is applied to soil using a drip system. In some instances, the pesticidal composition is applied to soil using a drench system. In some instances, the pesticidal composition is applied to plant roots or plant foliage (e.g., leaves, stems). In some instances, the pesticidal composition is applied to seeds. In some instances, the nematode or apicomplexan parasite infects a vertebrate. In some instances, the pesticidal composition is administered to non-human vertebrate. In some instances, the pesticidal composition is administered to a human. In some instances, the pesticidal composition is formulated as a drench to be administered to a non-human animal. In some instances, the pesticidal composition is formulated as an orally administered drug. In some instances, the pesticidal composition is formulated as an injectable drug.

Also described is a pesticidal feed for a non-human vertebrate including:

(a) a feed; and

(b) a pesticidal composition, including a pesticidal composition described herein.

In some instances, the feed has been treated to reduce choline content. In some instances, the feed is selected from the group consisting of: soy, wheat, corn, sorghum, millet, alfalfa, clover, and rye.

The term "halo" or "halogen" refers to any radical of fluorine, chlorine, bromine or iodine.

The term "alkyl" refers to a hydrocarbon chain that may be a straight chain or branched chain, containing the indicated number of carbon atoms. For example, C_1-C_{12} alkyl indicates that the group may have from 1 to 12 (inclusive) carbon atoms in it, e.g., 1 to 3, 1 to 4, 1 to 5, 1 to 6, 2 to 3, 2 to 4, 2 to 3, and 2 to 6, etc. Examples of alkyl include but are not limited to methyl, ethyl, propyl, isoproyl, butyl, isobutyl, tert-butyl, pentyl, hexyl, heptly, etc. The term "haloalkyl" refers to an alkyl in which one or more hydrogen atoms are replaced by a halogen, and includes alkyl moieties in which all hydrogens have been replaced by a halogen (e.g., perfluoroalkyl). The terms "arylalkyl" or "aralkyl" refer to an alkyl moiety in which an alkyl hydrogen atom is replaced by an aryl group (e.g, a C_6 aryl group). Aralkyl includes groups in which more than one hydrogen atom has been replaced by an aryl group. Examples of "arylalkyl" or "aralkyl" include benzyl, 9-fluorenyl, benzhydryl, and trityl groups.

The term haloalkyl refers to an alkyl chain where some of the hydrogens have been replaced by a halogen (e.g, F or Cl).

The term "cyclyl" refers to a saturated and partially unsaturated cyclic hydrocarbon group having 3 to 12 carbons, preferably 3 to 8 carbons, and more preferably 3 to 6 carbons. Examples of cyclyl groups include, but are not limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclopentenyl, cyclohexyl, cyclohexenyl, cycloheptyl, and cyclooctyl.

The term "alkenyl" refers to a straight or branched hydrocarbon chain containing 2-12 carbon atoms (e.g., 2 to 3, 2 to 4, 2 to 5, 2 to 6, 3 to 4, 3 to 5, 3 to 6 or 2 to 8 carbon ataoms) and having one or more double bonds. Examples of alkenyl groups include, but are not limited to, allyl, propenyl, 2-butenyl, 3-hexenyl and 3-octenyl groups. One of the double bond carbons may optionally be the point of attachment of the alkenyl substituent.

The term "alkynyl" refers to a straight or branched hydrocarbon chain containing 2-12 carbon atoms (e.g., 2 to 3, 2 to 4, 2 to 5, 2 to 6, 3 to 4, 3 to 5, 3 to 6 or 2 to 8 carbon ataoms and characterized in having one or more triple bonds. Examples of alkynyl groups include, but are not limited to, ethynyl, propargyl, and 3-hexynyl. One of the triple bond carbons may optionally be the point of attachment of the alkynyl substituent.

The term "alkoxy" refers to an -O-alkyl radical. The alkyl radical can include from 1 to 12 (inclusive) carbon atoms in it, e.g., 1 to 3, 1 to 4, 1 to 5, 1 to 6, 2 to 3, 2 to 4, 2 to 3, and 2 to 6, etc. Thus, alkoxy radical inlcude, e.g., methoxy, ethoxy, butoxy, etc.

The term "aryl" refers to an aromatic monocyclic, bicyclic, or tricyclic hydrocarbon ring system, having, for example, from 6 to 10 ring carbon atoms, and having at least one aromatic ring. wherein any ring atom capable of substitution can be substituted by a substituent. Examples of aryl moieties include, but are not limited to, phenyl, naphthyl, and anthracenyl.

The term "heteroaryl" refers to a monocyclic, bi- or tricyclic aromatic ring system (only one ring need to be aromatic) having from 5 to 14, preferably 5 to 10 ring atoms such as 5, 6, 7, 8, 9 or 10 ring atoms (mono- or bicyclic), in which one or more of the ring atoms are other than carbon, such as nitrogen, sulfur, oxygen and selenium as part of the ring system. Likewise, the term heteroaryloxy refers to a heteroaryl group

bonded to an oxygen atom. Examples of heteroaryl rings are pyrrole, imidazole, thiophene, furan, thiazole, isothiazole, thiadiazole, oxazole, isoxazole, oxadiazole, pyridine, pyrazine, pyrimidine, pyridazine, pyrazole, triazole, tetrazole, chroman, isochroman, quinoline, quinoxaline, isoquinoline, phthalazine, cinnoline, quinazoline, indole, isoindole, indoline (i e 2,3-dihydroindole), isoindoline (i.e. 1,3-dihydroisoindole), benzothiophene, benzofuran, isobenzofuran, benzoxazole, 2,1,3-benzoxadiazole, benzopyrazole; benzothiazole, 2,1,3-benzothiazole, 2,1,3-benzoselenadiazole, benzimidazole, indazole, benzodioxane, indane, 1,2,3,4-tetrahydroquinoline, 3,4-dihydro-2*H*-1,4-benzoxazine, 1,5-naphthyridine, 1,8-naphthyridine, pyrido[3,2-b]thiophene, tetralin, methylenedioxyindole, 2,3-dihydrobensofuran, 2,3-dihydrobensotiofen, 1,3-benzoxathiole, acridine, fenazine and xanthene.

The term "heterocyclyl" refers to a monocyclic, bi- or tricyclic non-aromatic (saturated or non-saturated) ring system having from 3 to 14, preferably 5 to 10 ring atoms such as 5, 6, 7, 8, 9 or 10 ring atoms (mono- or bicyclic), in which one or more of the ring atoms are other than carbon, such as nitrogen, sulfur, oxygen and selenium as part of the ring system.

The term "substituents" refers to a group "substituted" on an alkyl, cycloalkyl, alkenyl, alkynyl, heterocyclyl, heterocycloalkenyl, cycloalkenyl, aryl, or heteroaryl group at any atom of that group. Any atom can be substituted. Suitable substituents include, without limitation, alkyl, cycloalkyl, haloalkyl (e.g., perfluoroalkyl), aryl, heteroaryl, aralkyl, heteroaralkyl, heterocyclyl, alkenyl, alkynyl, cycloalkenyl, heterocycloalkenyl, alkoxy, haloalkoxy (perfluoroalkoxy), halo, hydroxy, carboxy, carboxylate, cyano, nitro, amino, alkyl aminosulfonate, sulfonate, sulfate, phosphate, methylenedioxy, ethylenedioxy, oxo, thioxo, imino (alkyl, aryl, aralkyl), $S(O)_n$alkyl (where n is 0-2), $S(O)_n$ aryl (where n is 0-2), $S(O)_n$ heteroaryl (where n is 0-2), $S(O)_n$ heterocyclyl (where n is 0-2), amine (mono-, di-, alkyl, cycloalkyl, aralkyl, heteroaralkyl, aryl, heteroaryl, and combinations thereof), ester (alkyl, aralkyl, heteroaralkyl, aryl, heteroaryl), amide (mono-, di-, alkyl, aralkyl, heteroaralkyl, aryl, heteroaryl, and combinations thereof), sulfonamide (mono-, di-, alkyl, aralkyl, heteroaralkyl, and combinations thereof). In one aspect, the substituents on a group are independently any one single, or any subset of the aforementioned substituents. In

another aspect, a substituent may itself be substituted with any one of the above substituents.

The compositions can also include one or more nematicides such as an avermectin (e.g., ivermectin), milbemycin, aldicarb, oxamyl, fenamiphos, fosthiazate or metam sodium. The composition may also include insecticides (e.g., cinnamaldehyde, sucrose octaonate esters, spinosad), herbicides (e.g., trifloxysulfuron, glyphosate, halosulfuron) and other chemicals for disease control (e.g., chitosan). The nematicidal compositions can also include co-solvents, permeation enhancers and aqueous surfactants.

A permeation enhancer is generally an agent that facilitates the active compounds of the invention, e.g., the ethanolamine analogs of the invention, to pass through cellular membranes.

A co-solvent (i.e., a latent solvent or indirect solvent) is an agent that becomes an effective solvent in the presence of an active solvent and can improve the properties of the primary (active) solvent.

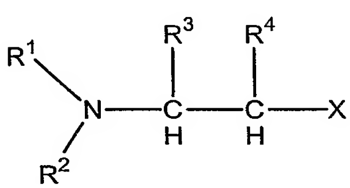
The composition can be produced in concentrated form that includes little or no water. The composition can be diluted with water or some other solvent prior to use to treat plants, seeds, soil or vertebrates.

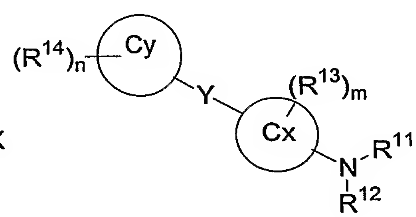
Also described is a nematicidal composition comprising: ethanolamine analogs or mixture of analogs selected from the group consisting of alkyl compounds N-ethylaniline and 4-(N-ethyl-N-methylamino)azobenzene, 4-(dimethylamino)azobenzene, 4-(N-methylamino)azobenzene, sulfonyl fluorides 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride and 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonyl fluoride, sulfonamides 2-(4-phenylazo-phenylamino)-ethanesulfonamide and 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonamide, the trifluoromethyl sulfonamide C,C,C-Trifluoro-N-(2-phenylamino-ethyl)-methanesulfonamide, alcohols 2-(diisopropylamino)ethanol, 2-(tert-butylamino)ethanol, N-(2-hydroxyethyl)aniline and D-phenylalaninol and their phosphate, phosphate diester, phophonate, phosphonate diester, alpha-fluorinated phosphonate, alpha-fluorinated phosphonate diester, sulfonate and sulfonate esters. Preferred esters include methyl esters, ethyl esters, phenyl esters, alkoxyalkyl (e.g., pivaloyloxymethyl) esters and alkoxyphenyl (e.g., phenoxyethyl) esters.

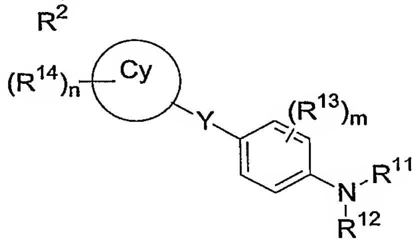
In various preferred embodiments the composition further comprises an aqueous surfactant or surfactant mixture selected from the group consisting of: ethyl lactate, Span 20, Span 40, Span 80, Span 85, Tween 20, Tween 40, Tween 80, Tween 85, Triton X 100, Makon 10, Igepal CO 630, Brij 35, Brij 97, Tergitol TMN 6, Dowfax 3B2, Physan and Toximul TA 15; the composition further comprises a permeation enhancer (e.g., cyclodextrin); the composition further comprises a co-solvent (e.g., isopropanol, acetone, 1,2-propanediol, a petroleum based-oil (e.g., aromatic 200) or a mineral oil (e.g., paraffin oil)); the composition further comprises a nematicide selected from the group consisting of: avermectins (e.g., ivermectin), milbemycin, aldicarb, oxamyl, fenamiphos, fosthiazate and metam sodium. The composition may also comprise insecticides (e.g., cinnamaldehyde, sucrose octaonate esters, spinosad), herbicides (e.g., trifloxysulfuron, glyphosate, halosulfuron) and other chemicals for disease control (e.g., chitosan).

Described herein are methods for controlling nematodes or apicomplexan parasites by administering a compound described herein. The methods include administering to vertebrates, plants, seeds or soil a nematicidal composition comprising:

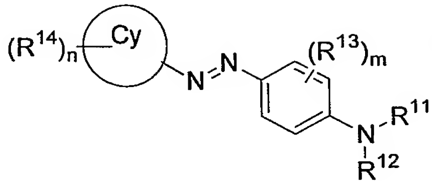
(a) an effective amount of a compound or a mixture of compounds having any of the formulae described herein, for example one of the following formulas: formulas:



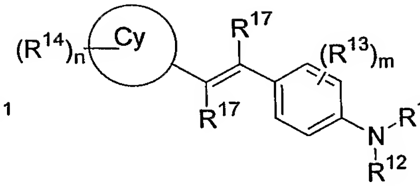




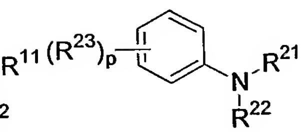
Formula (I) Formula (IIa) Formula (IIb)



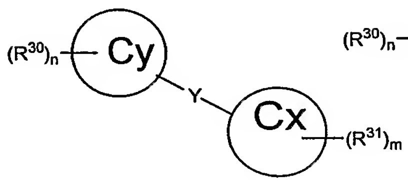
Formula (IIc)



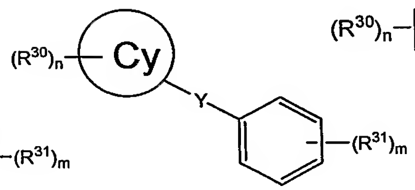
Formula (IId)



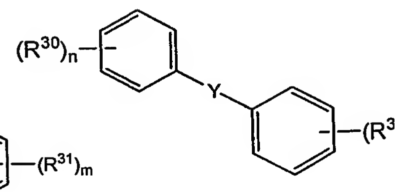
Formula (III)



Formula (IVa)



Formula (IVb)



Formula (IVc)

The compositions can also include one or more nematicides such as an avermectin (e.g., ivermectin), milbemycin, aldicarb, oxamyl, fenamiphos, fosthiazate or metam sodium. The composition may also include insecticides (e.g., cinnamaldehyde, sucrose octaonate esters, spinosad), herbicides (e.g., trifloxysulfuron, glyphosate, halosulfuron) and other chemicals for disease control (e.g., chitosan). The nematicidal compositions can also comprise co-solvents, permeation enchancers and aqueous surfactants.

Also features is a method for control of unwanted nematodes or apicomplexa comprising administering to vertebrates, plants, seeds or soil a nematicidal composition comprising an effective amount of: (a) a compound selected from the group consisting of alkyl compounds N-ethylaniline and 4-(N-ethyl-N-methylamino)azobenzene, 4-(dimethylamino)azobenzene, 4-(N-methylamino)azobenzene, sulfonyl fluorides 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride and 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonyl fluoride, sulfonamides 2-(4-phenylazo-phenylamino)-ethanesulfonamide and 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonamide, the trifluoromethyl sulfonamide C,C,C-Trifluoro-N-(2-phenylamino-ethyl)- methanesulfonamide), alcohols 2-(diisopropylamino)ethanol, 2-

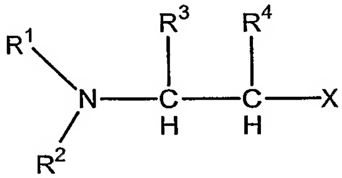
(tert-butylamino)ethanol and N-(2-hydroxyethyl)aniline and D-phenylalaninol and their phosphate, phosphate diester, phophonate, phosphonate diester, flurophosphonate, alpha-fluorinated phosphonate diester, sulfonate and sulfonate esters. Preferred esters include methyl esters, ethyl esters, phenyl esters, alkoxyalkyl (e.g., pivaloyloxymethyl) esters and alkoxyphenyl (e.g., phenoxyethyl) esters.

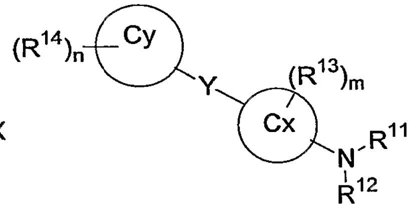
In certain embodiments of the method the composition further comprises an aqueous surfactant or surfactant mixture selected from the group consisting of: ethyl lactate, Span 20, Span 40, Span 80, Span 85, Tween 20, Tween 40, Tween 80, Tween 85, Triton X 100, Makon 10, Igepal CO 630, Brij 35, Brij 97, Tergitol TMN 6, Dowfax 3B2, Physan and Toximul TA 15; the composition may comprise a permeation enhancer (e.g., a cyclodextrin); the composition may comprise a co-solvent (e.g., isopropanol, acetone, 1,2-propanediol, a petroleum based-oil (e.g., aromatic 200) or a mineral oil (e.g., paraffin oil)); the method includes administering (before, after or in conjunction with the ethanolamine analog) a nematicide selected from the group consisting of avermectins (e.g., ivermectin), milbemycin, aldicarb, oxamyl, fenamiphos, fosthiazate and metam sodium, an insecticide (e.g., cinnamaldehyde, sucrose octaonate esters, spinosad), a herbicide (e.g., trifloxysulfuron, glyphosate, halosulfuron) and/or other chemicals for disease control (e.g., chitosan); the nematode infects plants and the pesticidal composition is applied to the soil or to plants; the pesticidal composition is applied to soil before planting; the pesticidal composition is applied to soil after planting; the pesticidal composition is applied to soil using a drip system; the pesticidal composition is applied to soil using a drench system; the pesticidal composition is applied to plant roots; the pesticidal composition is applied to seeds; the pesticidal composition is applied to the foliage of plants; the nematode or apicomplexan infects a vertebrate; the pesticidal composition is administered to a bird or non-human mammal; the pesticidal composition is administered to a human; the pesticidal composition is formulated as a drench to be administered to a non-human animal; the pesticidal composition is formulated as an orally administered drug; and the pesticidal composition is formulated as an injectable drug.

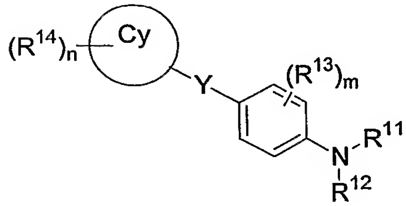
Also described are feeds that have been supplemented to include one or more of the compounds described herein.

Thus, the invention features a pesticidal feed for a non-human vertebrate comprising: (a) an animal feed; (b) an effective amount of a nematicidal compound or

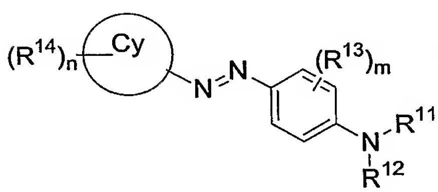
mixtures of compounds having any of the formulae described herein, for example having one of the formula below. formulas:

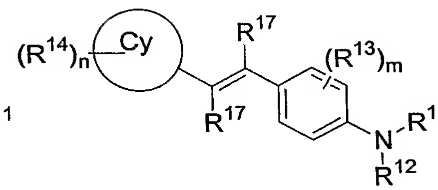


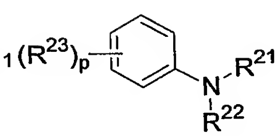




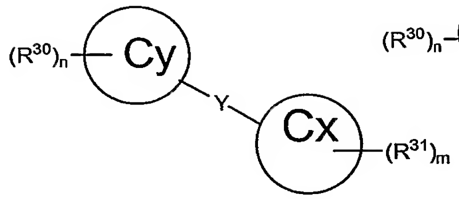
Formula (I) Formula (IIa) Formula (IIb)



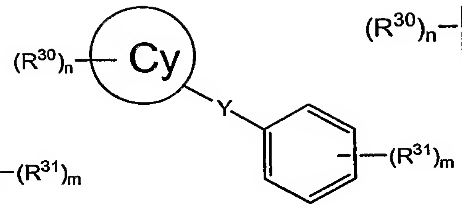




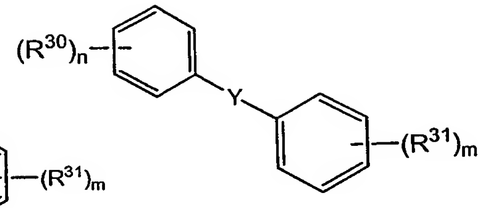
Formula (IIc) Formula (IId) Formula (III)



Formula (IVa)



Formula (IVb)



Formula (IVc)

The feed can be treated to reduce choline content. The feed can be selected from the group consisting of: soy, wheat, corn, sorghum, millet, alfalfa, clover, and rye.

As used herein, an agent with "anthelmintic or anthelminthic or antihelminthic activity" is an agent, which when tested, has measurable nematode-killing activity or results in reduced fertility or sterility in the nematodes such that fewer viable or no offspring result, or compromises the ability of the nematode to infect or reproduce in its host, or interferes with the growth or development of a nematode. The agent may also display nematode repellant properties. In the assay, the agent is combined with nematodes, e.g., in a well of microtiter dish, in liquid or solid media or in the soil containing the agent. Staged nematodes are placed on the media. The time of survival, viability of offspring, and/or the movement of the nematodes are measured. An agent with "anthelmintic or anthelminthic or antihelmthic activity" can, for example, reduce the survival time of adult nematodes relative to unexposed similarly staged adults, e.g., by about 20%, 40%, 60%, 80%, or more. In the alternative, an agent with "anthelmintic or anthelminthic or antihelminthic activity" may also cause the nematodes to cease replicating, regenerating, and/or producing viable progeny, e.g., by about 20%, 40%, 60%, 80%, or more. The effect may be apparent immediately or in successive generations.

As used herein, the term "altering an activity" refers to a change in level, either an increase or a decrease in the activity, (e.g., an increase or decrease in the ability of the polypeptide to bind or regulate other polypeptides or molecules) particularly a PEAMT-like activity (e.g., the ability to methylate pEA, pMME or pDME). The change can be detected in a qualitative or quantitative observation. If a quantitative observation is made, and if a comprehensive analysis is performed over a plurality of

observations, one skilled in the art can apply routine statistical analysis to identify modulations where a level is changed and where the statistical parameter, the p value, is, for example, less than 0.05.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIG. 1 is a set of drawings depicting the structures of ethanolamine and its methylated analogs monomethylethanolamine (MME), dimethylethanolamine (DME) and choline chloride (Cho Cl). Also shown are phosphoethanolamine (pEA) a substrate of PEAMTs, two phosphonic analogs of pEA (2-aminoethylphosphonic acid and 3-aminopropylphosphonic acid) and a sulfonic analog of pEA (taurine).

FIG. 2 depicts drawings of four pesticidal ethanolamine (alcohol) analogs: 2-(diisopropylamino)ethanol, 2-(tert-butlylamino)ethanol, D-phenylalaninol and N-(2-hydroxyethyl)aniline.

FIG. 3 shows ethanolamine and a sulfonic acid analog taurine and the nematicidal N-(2-hydroxyethyl)aniline analog and its corresponding sulfonic acid analog N-phenyltaurine.

FIG. 4 shows a test of 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride (3746) against root knot nematode (*Meloidogyne incognita*) on tomato plants grown in pots. Active ingredients are added to the soil to mimic three field rates of 25, 10 and 5 kilograms per hectare. Top panel shows the degree of nematode control (gall ratings) and lower panel the assessment of phytotoxicity (root weights)

DETAILED DESCRIPTION

Choline (Cho) plays a number of important roles in biological systems. In bacteria, fungi, plants and animals, phosphatidylcholine is a major component of membrane phospholipids and the free base is a precursor to the neurotransmitter acetylcholine in animals. Choline is also an intermediate in glycine betaine (a compound that increases tolerance to osmotic stresses) synthesis in plants (McNeil et al. (2001) Proc Natl Acad Sci USA 98:10001-5). Choline is an essential nutrient in

humans and other animals, and also plays a critical role in brain development in humans (Sheard et al. (1986) Am J Clin Nutr. 1986 43:219-24; Tayek et al. (1990) J Am Coll Nut 9:76-83). Most organisms can incorporate choline into phosphatidylcholine using a pathway that transfers a choline moiety from CDP-choline to diacylglycerol. In similar fashion, choline precursors such as ethanolamine (EA), monomethylethanolamine (MME) and dimethylethanolamine (DME) can also be incorporated into phospholipids via the CPD-choline or Kennedy pathway. Rhizobacteria have an additional Kennedy-independent pathway that also allows the incorporation of choline excreted from plant roots directly into phospholipids (Rudder et al. (1999) J Biol Chem. 274:20011-6; Lopez-Lara & Geiger (2001) J Biotechnol 91:211-21).

Among those organisms that can synthesize choline, different biosynthetic pathways are used to make choline from ethanolamine via the successive addition of methyl groups using S-adenosyl methionine (SAM) as the methyl donor. These pathways differ in whether they use the free base (ethanolamine), the phosphobase (phosphoethanolamine), or the phosphatidyl base (phosphatidylethanolamine) as the methylation substrate. Plants are unusual in that they can methylate the free base, phosphobase or phosphatidylbase (phospholipid substrate) (Bolognese & McGraw (2000) Plant Physiol. 124(4):1800-13; Nuccio et al. (2000) J Biol Chem 275(19):14095-101; Charron et al. (2002). Plant Physiol. 129(1):363-73). However, the conversion of phosphatidylethanolamine to phosphatidylmonomethylethanolamine has not been demonstrated in plants, so the first methylation reaction probably occurs at either the free base or the phosphobase level. It is now thought that in many plants the major flux occurs at the phosphobase level, catalyzed by the phosphoethanolamine N-methyltransferase enzyme (PEAMT) (i.e., pEA $\Rightarrow$ pMME).

In contrast, in most other organisms, methylation is carried out primarily at the phospholipid level. The complete reaction (i.e., Ptd-EA $\Rightarrow$ Ptd-MME $\Rightarrow$ Ptd-DME $\Rightarrow$ PtdCho) requires a single enzyme in bacteria and mammals and two separate enzymes in fungi (Kanipes & Henry. (1997) Biochim Biophys Acta. 1348(1-2):134-41; Vance et al. (1997) Biochim Biophys Acta. 1348(1-2):142-50; Hanada et al. (2001) Biosci Biotechnol Biochem. 65(12):2741-8). Mammalian nerve cells are reported to have additional phopho-base methylation activity and three distinct enzymes appear to be

involved (Andriamampandry et al. (1992) Biochem J. 288 (1):267-72; Mukherjee et al. (1995) Neurochem Res. 20(10):1233-7).

Plant methyltransferases from spinach and Arabidopsis have been cloned by complementation of choline biosynthetic mutants in fission and budding yeast, respectively (Bolognese & McGraw (2000) Plant Physiol. 124(4):1800-13; Nuccio et al. (2000) J Biol Chem. 275(19):14095-101). In contrast to yeast methyltransferases, which act on the phosphatidylethanolamine, these plant enzymes have been shown to act on phosphoethanolamine. A similar gene has recently been cloned from chilled wheat tissues (Charron et al. (2002). Plant Physiol. 129(1):363-73). The plant enzymes are predicted to encode soluble proteins of approximately 55kDa that have two domains containing separate SAM binding sites. Each domain contains motifs - termed I, post-I, II, and III – that are conserved among SAM-dependent methyltransferases. cDNA clones encompassing partial sequence from both SAM binding sites have been isolated from numerous plants, including Oryza sativa, Brassica napus, Gossypium hirsutum, and Hordeum vulgare. The plant methyltransferase structure is thought to have arisen from a gene duplication event, since prokaryotic and animal methyltransferases are approximately half the size of the plant enzymes and have only one methyltransferase domain.

Some basic kinetic characteristics of the spinach methyltransferase have been determined from enzyme preparations isolated from fission yeast overexpressing it. Enzyme activity is dependent on SAM and phosphoethanolamine concentrations. In the presence of these substrates, methyltransferase-containing extracts catalyze the formation of monomethyl- and dimethylphosphoethanolamine as well as phosphocholine. The appearance of these intermediates suggests that they are precursors to phosphocholine. A truncated version of the spinach enzyme lacking the second SAM binding site can accomplish the first methylation converting phosphoethanolamine to monomethylphosphoethanolamine, but cannot perform the second and third methylation steps. It is presumed that the C-terminal half can carry out the second and third methylation reactions.

The *C. elegans* genome contains two PEAMT-like genes and several homologs are found in other nematode EST datasets suggesting that these genes are widely distributed in Nematoda. The nematode proteins and plant homologs are all presumably localized in the cytosol as in the case of the wheat PEAMT as they lack

secretion leaders (analyzed by methods available on the internet at cbs.dtu.dk/services/TargetP or transmembrane regions (analyzed by methods available on the internet at dtu.dk/services /TMHHMM. One of the *C. elegans* PEAMT genes (PEAMT2) encodes a polypeptide which is 437 amino acids long (accession number AAB04824.1, wormbase locus F54D11.1) and shows significant similarity to the C-terminal half of the spinach PEAMT and other plant homologs with two SAM binding domains. The second *C. elegans* PEAMT gene appears to encode at least to two different splice variants (PEAMT1a and PEAMT1b). PEAMT1a and b are 495 and 484 amino acids long, respectively (accession number AAA81102.1, wormbase locus ZK622.3a and ZK622.3b) and are most similar to the N-terminal half of the plant PEAMTs. A PFAM analysis (available on the internet at pfam.wustl.edu) supports the blast predictions that whereas the plant PEAMTs contain two canonical methyltransferase domains, the nematode proteins contain an N-terminal MT domain in PEAMT1 and a C-terminal MT domain in PEAMT2. PEAMT1 and PEAMT2 have 30-40% amino acid identity to their plant homologs in the regions that align. The similarity between PEAMT1 and PEAMT2 is low (22 % amino acid identity) and is restricted to a small 127 amino acid region in their C-terminal domains.

Given the similarity of PEAMT1 and PEAMT2 to the N- and C-terminal domains of the plant PEAMTs (e.g. spinach and *Arabidopsis*) respectively, their similar larval lethal RNAi phenotypes and the observation that the N-terminal half of the spinach enzyme is only capable of the first methylation reaction, we predicted that PEAMT1 would catalyze the conversion of pEA to pMME (the first methylation) and PEAMT2 would catalyze the conversion of pMME to pDME and pDME to pCHO. This hypothesis was confirmed by chemical complementation of the C. elegans PEAMT1 or PEAMT2 RNAi phenotypes with EA, MME, DME or Cho (see Table 1). As predicted, the PEAMT1 larval lethal RNAi phenotype is suppressed by MME, DME and Cho but not by EA whereas the PEAMT2 RNAi is rescued only by Cho and not by MME, DME, or EA singly or in combination.

With the sequencing of the Plasmodium falciparum genome, a 266 amino acid PEAMT homolog has been identified which has 36% amino acid identity (58% amino acid similarity) to the C-terminal half of the C. elegans PEAMT2 protein. Despite being half the size of the plant and nematode PEAMT enzymes, the P. falciparum homolog catalyzes all three phosphobase methylation reactions producing pCHO from

pEA (Pessi et al. (2004) Proc Natl Acad Sci U S A. 101(16):6206-11). The plasmodium enzyme is inhibited by the phosphocholine analog miltefosine which in turn inhibits parasite proliferation within human erythrocytes suggesting that P. falciparum PEAMT is a potential target for control of this apicomplexan parasite.

Decribed herein are certain compounds, some of which are N-substituted and C-substituted ethanolamine analogs (e.g., N-ethylaniline, 4-(N-ethyl-N-methylamino)azobenzene, 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride, 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonyl fluoride, 2-(4-phenylazo-phenylamino)-ethanesulfonamide, 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonamide, C,C,C-Trifluoro-N-(2-phenylamino-ethyl)-methanesulfonamide, 2-(diisopropylamino)ethanol, 2-(tert-butylamino)ethanol, N-(2-hydroxyethyl)aniline and D-phenylalaninol; see Tables 3, 4 and 5) are nematicidal.

The nematicidal compounds may be supplied to plants exogenously, through sprays for example. These compounds may also be applied as a seed coat. It is also possible to provide the compounds through a host organism or an organism on which the nematode feeds or which the apicomplexan parasite infects. In the case of PMEAT inhibitors, the host organism or organism on which the nematode feeds may or may not be engineered to produce lower amounts of choline. For example, a host cell that does not naturally produce the nematicide can be transformed with genes encoding enzymes capable of making the nematicidal compound and provided with appropriate precursor chemicals exogenously if necessary. Alternatively, the active nematicide and precursors can be made endogenously by the expression of the appropriate enzymes. In addition, yeast or other organisms can be modified to produce nematicides. Nematodes that feed on such organisms would then be exposed to the inhibitors.

The compounds can be applied to plants or the environment of plants needing nematode control, or to animals or the food of animals needing nematode or apicomplexan parasite control. The compositions may be applied by, for example drench or drip techniques. With drip applications compounds can be applied directly to the base of the plants or the soil immediately adjacent to the plants. The composition may be applied through existing drip irrigation systems. This procedure is particularly applicable for cotton, strawberries, tomatoes, potatoes, vegetables and ornamental plants. Alternatively, a drench application can be used where a sufficient quantity of pesticidal composition is applied such that it drains to the root area of the plants. The

drench technique can be used for a variety of crops and turf grasses. The drench technique can also be used for animals. Preferably, the pesticidal compositions would be administered orally to promote activity against internal parasitic nematodes or apicomplexa. Pesticidal compositions may also be administered in some cases by injection of the host animal.

The concentration of the pesticidal composition should be sufficient to control the parasite without causing significant phytotoxicity to the desired plant or undue toxicity to the animal host.

An important aspect of the invention is the surprising discovery that certain ethanolamine analogs (e.g., N-ethylaniline, 4-(N-ethyl-N-methylamino)azobenzene, 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride, 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonyl fluoride, 2-(4-phenylazo-phenylamino)-ethanesulfonamide, 2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonamide, C,C,C-Trifluoro-N-(2-phenylamino-ethyl)-methanesulfonamide, 2-(diisopropylamino)ethanol, 2-(tert-butylamino)ethanol, N-(2-hydroxyethyl)aniline and D-phenylalaninol) that are predicted to be specific inhibitors of nematode PEAMTs are pesticidal. Thus, these analogs and their corresponding phosphate diesters, phosphonate diesters, fluorinated phosphonate diesters and sulfonate esters will provide useful compounds for nematode or apicomplexan parasite control.

The pesticidal agents decribed herein can be applied in conjunction with another pesticidal agent. The second agent may, for example, be applied simultaneously or sequentially. Such pesticidal agents can include for example, avermectins for animal applications.

A pesticidal compound may also be coupled to an agent such as glyphosate or polyoxyethylene sorbitan (Tween headgroup) to improve phloem mobility to the roots of plants.

The aforementioned nematicidal compositions can be used to treat diseases or infestations caused by nematodes of the following non-limiting, exemplary genera: *Anguina, Ditylenchus, Tylenchorhynchus, Pratylenchus, Radopholus, Hirschmanniella, Nacobbus, Hoplolaimus, Scutellonema, Rotylenchus, Helicotylenchus, Rotylenchulus, Belonolaimus, Heterodera, other cyst nematodes, Meloidogyne, Criconemoides, Hemicycliophora, Paratylenchus, Tylenchulus, Aphelenchoides, Bursaphelenchus, Rhadinaphelenchus, Longidorus, Xiphinema, Trichodorus,* and *Paratrichodorus,*

Dirofiliaria, Onchocerca, Brugia, Acanthocheilonema, Aelurostrongylus, Anchlostoma, Angiostrongylus, Ascaris, Bunostomum, Capillaria, Chabertia, Cooperia, Crenosoma, Dictyocaulus, Dioctophyme, Dipetalonema, Dracunculus, Enterobius, Filaroides, Haemonchus, Lagochilascaris, Loa, Manseonella, Muellerius, Necator, Nematodirus, Oesophagostomum,Ostertagia, Parafilaria, Parascaris, Physaloptera, Protostrongylus, Setaria, Spirocerca, Stephanogilaria, Strongyloides, Strongylus, Thelazia, Toxascaris, Toxocara, Trichinella, Trichostrongylus, Trichuris, Uncinaria, and *Wuchereria.* Particularly preferred are nematodes including *Dirofilaria, Onchocerca, Brugia, Acanthocheilonema, Dipetalonema, Loa, Mansonella, Parafilaria, Setaria, Stephanofilaria,* and *Wucheria, Pratylenchus, Heterodera, Meloidogyne, Paratylenchus.* Species that are particularly preferred are*: Ancylostoma caninum, Haemonchus contortus, Trichinella spiralis, Trichurs muris, Dirofilaria immitis, Dirofilaria tenuis, Dirofilaria repens, Dirofilari ursi, Ascaris suum, Toxocara canis, Toxocara cati, Strongyloides ratti, Parastrongyloides trichosuri, Heterodera glycines, Globodera pallida, Meloidogyne javanica, Meloidogyne incognita,* and *Meloidogyne arenaria, Radopholus similis, Longidorus elongatus, Meloidogyne hapla*, and *Pratylenchus penetrans.*

The following examples are, therefore, to be construed as merely illustrative, and not limitative of the remainder of the disclosure in any way whatsoever. All of the publications cited herein are hereby incorporated by reference in their entirety.

EXAMPLES

Example 1

RNA Mediated Interference (RNAi)

A double stranded RNA (dsRNA) molecule can be used to inactivate a phosphoethanolamine N-methyl transferase (PEAMT) gene in a cell by a process known as RNA mediated-interference (Fire et al. (1998) Nature 391:806-811, and Gönczy et al. (2000) Nature 408:331-336). The dsRNA molecule can have the nucleotide sequence of a PEAMT nucleic acid (preferably exonic) or a fragment thereof. For example, the molecule can comprise at least 50, at least 100, at least 200, at least 300, or at least 500 or more contiguous nucleotides of a PEAMT-like gene. The dsRNA molecule can be delivered to nematodes via direct injection, by soaking nematodes in aqueous solution containing concentrated dsRNA, or by raising

bacteriovorous nematodes on E. coli genetically engineered to produce the dsRNA molecule (Kamath et al. (2000) Genome Biol. 2; Tabara et al. (1998) Science 282:430-431).

PEAMT RNAi by feeding:

C. elegans can be grown on lawns of E. coli genetically engineered to produce double-stranded RNA (dsRNA) designed to inhibit PEAMT1 or PEAMT2 expression. Briefly, E. coli were transformed with genomic fragments encoding portions of the C. elegans PEAMT1 or the PEAMT2 gene. Specifically, a 960 nucleotide fragment was amplified from the PEAMT1 gene using oligo-nucleotide primers containing the sequences 5'-ATGGTGAACGTTCGTCGTGC-3' and 5'-CATACGTATTTCTCATCATC-3' respectively, or an 854 nucleotide fragment was amplified from the PEAMT2 gene using oligo-nucleotide primers containing the sequences 5'-CCAGATTATTACCAACGCCG-3' and 5'-TGAACTTACATAGATTCTTG-3' respectively. The PEAMT1 and PEAMT2 genomic fragments were cloned separately into an E. coli expression vector between opposing T7 polymerase promoters. The clone was then transformed into a strain of E. coli that carries an IPTG-inducible T7 polymerase. As a control, E. coli was transformed with a gene encoding the Green Fluorescent Protein (GFP). Feeding RNAi was initiated from C. elegans larvae at 23 °C on NGM plates containing IPTG and E. coli expressing the C. elegans PEAMT1 or PEAMT2, or GFP dsRNA. If the starting worm (the P0) was an L1, or a dauer larva, the phenotype of both the PEAMT1 and PEAMT2 RNAi-generated mutants was complete or almost complete sterility. One the other hand, if the P0 animal was an L4 larva, then the phenotype of both the PEAMT1 and PEAMT2 RNAi-generated mutants was L1/L2 larval arrested development and lethality. The sequence of the PEAMT1 and PEAMT2 genes is of sufficiently high complexity (i.e., unique) such that the RNAi is not likely to represent cross reactivity with other genes.

C. elegans cultures grown in the presence of E. coli expressing dsRNA from the PEAMT1 or the PEAMT2 gene were strongly impaired indicating that the PEAMT genes provide essential functions in nematodes and that dsRNA from the PEAMT-like genes is lethal when ingested by C. elegans. These results demonstrate that PEAMT's are important for the viability of C. elegans and suggest that they are useful targets for the development of compounds that reduce the viability of nematodes.

Example 2

Chemical rescue of the PEAMT1 and PEAMT2 RNAi-generated phenotype.

The experiments described below were designed to test whether the PEAMT1/PEAMT2 RNAi knockout phenotype can be rescued by providing C. elegans with the products downstream of the predicted PEAMT reaction catalyzed by the enzymes. The free bases (EA, MME, DME and Cho) were added to the bacterial medium and it was assumed that these would be taken up and converted to the corresponding phosphobases by the actions of ethanolamine/choline kinases.

C. elegans worms were fed bacteria expressing dsRNA homologous to PEAMT1, PEAMT2, actin, or GFP along with specific chemicals (EA, MME, DME or Cho). Chemicals were added to NGM plates at various concentrations and negative (GFP dsRNA) and positive (actin dsRNA) controls were performed for each chemical or chemical mixture at each concentration. Specifically, agar plates containing NGM and the chemicals specified in Table 1 (see below) were seeded with bacteria expressing double-stranded RNA homologous to either PEAMT1 or PEAMT2. In some experiments a single L1 or dauer larva was placed on each plate, and the P0 and the F1 were examined for the next 5 days. In other experiments, a single L4 C. elegans hermaphrodite was placed on each plate. The hermaphrodite was allowed to lay eggs for 24 hours and the phenotype of the F1 progeny was scored 48 hours after the initial 24-hour egg-laying period. At the time of scoring, 4 individual F1 progeny were cloned to separate plates containing the same chemical and bacteria they were grown on. The F1 and F2 progeny were examined over the next 4-5 days for the presence of a phenotype.

Table 1: C. elegans PEAMT1 and PEAMT2 RNAi feeding phenotypes (starting with C. elegans L1, dauer, or L4 larva as the P0 animal).

P0	Compounds added to the plate media	F1 phenotype	
		PEAMT1 dsRNA	**PEAMT2 dsRNA**
L1	None	Sterility	Sterility
	10 mM DME	**Fertile adults**	Sterility

Dauer	None	Partial sterility	Partial sterility
	10 mM DME	**Fertile adults**	Sterility
L4	None	L1/L2 arrest/lethality	L1/L2 arrest/lethality
	10 mM ethanolamine (EA)	L1/L2 arrest/lethality	L1/L2 arrest/lethality
	5 or 10 mM MME	**Fertile adults**	L1/L2 arrest/lethality
	5 or 10 mM DME	**Fertile adults**	L1/L2 arrest/lethality
	5 mM choline (Cho)	L1/L2 arrest/lethality	L1/L2 arrest/lethality
	10 or 15 mM Cho	Sterile adults	L1/L2 arrest/lethality
	25 mM or 30 mM Cho	**Fertile adults**	**Fertile adults**
	5 mM each EA, MME 5 mM each EA, DME 5 mM each EA, Cho 5 mM each MME, DME 5 mM each MME, Cho 5 mM each DME, Cho 5 mM each MME, DME, Cho	**Fertile adults**	L1/L2 arrest/lethality

The C. elegans phosphoethanolamine N-methyltransferase proteins PEAMT1 and PEAMT2 together catalyze the conversion of phosphoethanolamine to phosphocholine. The RNAi-generated mutants of PEAMT1 or PEAMT2 are both predicted to have decreased levels of choline which leads to sterility, or L1/L2 larval arrested development and death. Addition of 25 mM choline rescues the larval arrest associated with both PEAMT1 and PEAMT2 RNAi phenotypes. However, only the PEAMT1 mutants are rescued by the addition of 5 mM monoethanolamine (MME) or 5 mM dimethylethanolamine (DME) while the PEAMT2 mutants are not (see Table 1). These data are consistent with the prediction that PEAMT1 catalyzes the first methylation while PEAMT2 catalyzes the second and third methylations in the conversion of pEA to pCho:

$$\mathbf{pEA} \xrightarrow[\text{PEAMT1}]{} \mathbf{pMME} \xrightarrow[\text{PEAMT2}]{} \mathbf{pDME} \xrightarrow[\text{PEAMT2}]{} \mathbf{pCho}$$

Five mM DME rescues the sterility associated with PEAMT1 RNAi . The rescue by DME strongly suggests the sterility is due to a reduction in choline production and not due to other changes caused by the PEAMT mutations.

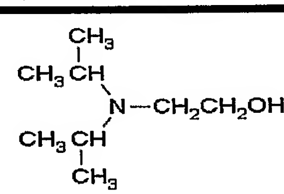
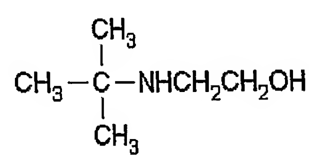
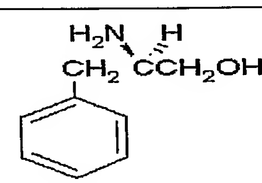
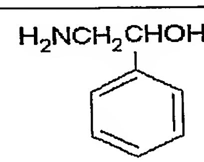
The data also demonstrate that when choline alone is used as the rescuing chemical, 25 mM choline is required to complement the PEAMT1 and PEAMT2 RNAi phenotypes. This suggests that chemicals that interfere with this pathway will not likely be counteracted by the amount of choline nematodes can acquire from the environment.

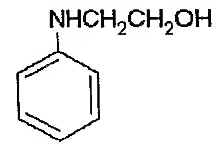
Example 3

Nematicidal Activity of Small Molecules Structurally Similar to Ethanolamine Against *Caenorhabditis elegans*

The structures of ethanolamine-like molecules tested against *C. elegans* for nematicidal activity are shown below.

Table 2:

COMPOUND	STRUCTURE
2-(diisopropylamino)ethanol (N-substituted)	
2-(tert-butylamino)ethanol (N-substituted)	
D-phenylalaninol (C2-subsitituted)	
2-amino-1-phenylethanol (C1-subsitituted)	

N-(2-hydroxyethyl)aniline (N-substituted)	

One approach to the development of chemicals that interfere with the function of an enzyme is to identify compounds that mimic substrate binding but that cannot be acted on by the enzyme. Therefore, several ethanolamine-derived compounds were tested for the ability to kill *C. elegans* in culture. Compounds with substitutions at various positions on ethanolamine were tested including some with substitutions on the nitrogen, the carbon adjacent to the nitrogen (C2), and on the carbon adjacent to the oxygen (C1).

A single *C. elegans* L4 larva (the P0 animal) was placed on a lawn of *E. coli* that had been spotted onto NGM plates containing various concentrations of the ethanolamine-like compounds. The growth and development of the P0 and its F1 progeny at 23 °C was monitored by visual observation over several days. Four of the compounds tested [2-(diisopropylamino)ethanol, 2-(tert-butylamino)ethanol, D-phenylalaninol and N-(2-hydroxyethyl)aniline], showed nematicidal activity against *C. elegans*. In addition, the phenotype of worms treated with the nematicidal ethanolamine-like compounds mimicked the RNAi-phenotype of PEAMT1 and PEAMT2. That is, the F1 progeny of the treated worm did not develop beyond the L1/L2 stage and died. Treatment of *C. elegans* with the C1-substituted compound 2-amino-1-phenylethanol showed no nematicidal effect.

Table 3: Nematicidal activity of ethanolamine-like compounds against *C. elegans*.

COMPOUND	CONCENTRATION	F1 PHENOTYPE
2-(diisopropylamino)ethanol	10 mM	L1/L2 arrest/lethality
2-(tert-butylamino)ethanol	10 mM	L1/L2 arrest/lethality
D-phenylalaninol	10 mM	L1/L2 arrest/lethality
2-amino-1-phenylethanol	25 mM	Wild-type development
N-(2-hydroxyethyl)aniline	10 mM	L1/L2 arrest/lethality
Control (no compound)	Not applicable	Wild-type development

Example 4

Table 4: Nematicidal activity of ethanolamine-like compounds against other nematodes.

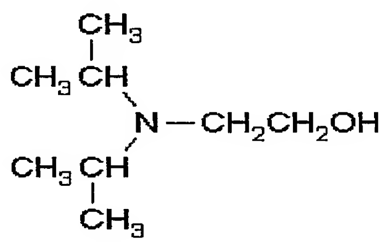
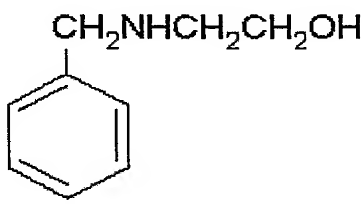
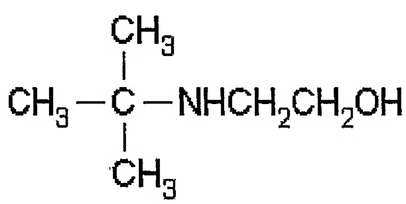
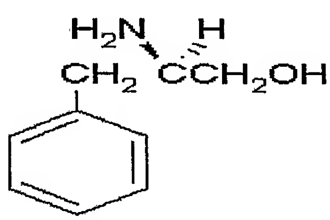
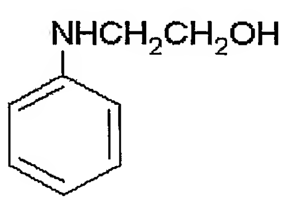
The ethanolamine-like compounds noted above are also nematicidal against *Acrobiloides ellesmerensis* and *Cephalobus sp.* Assays were done as those described for *C. elegans* L4 larvae. Three of the four compounds that were nematicidal against *C. elegans* were tested and were found to be nematicidal against *A. ellesmerensis* and *Cephalobus sp.*

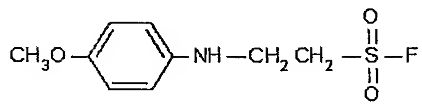
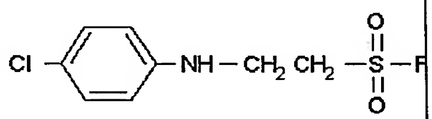
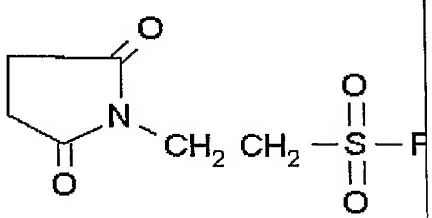
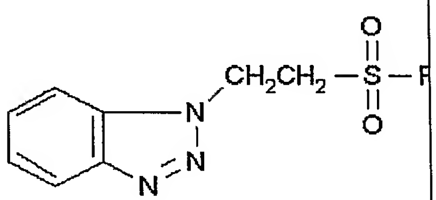
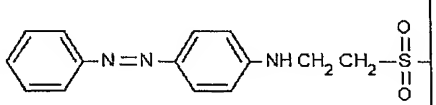
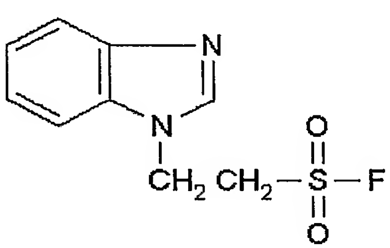
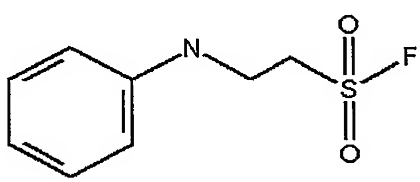
COMPOUND	SPECIES	CONCENTRATION	F1 PHENOTYPE
diisopropylamino)ethanol	*A. ellesmerensis*	10 mM	L1/L2 arrest/lethality
	Cephalobus sp.	10 mM	L1/L2 arrest/lethality
2-(tert-butylamino)ethanol	*A. ellesmerensis*	10 mM	L1/L2 arrest/lethality
	Cephalobus sp.	10 mM	L1/L2 arrest/lethality
D-phenylalaninol	*A. ellesmerensis*	12.5 mM	L1/L2 arrest/lethality
	Cephalobus sp.	12.5 mM	L1/L2 arrest/lethality
Control (no compound)	*Cephalobus sp.*	not applicable	Wild-type

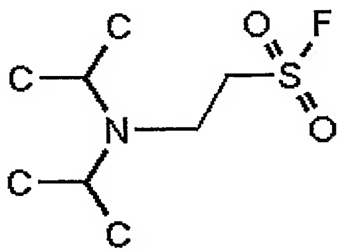
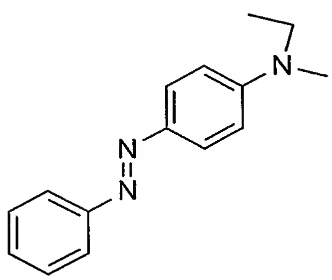
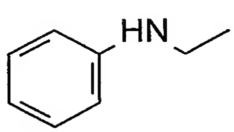
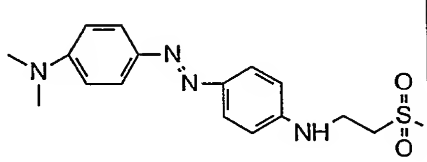
Jeremy: Delete this paragraph: [*Sulfonic, phosphonic, or phosphate prodrugs based on the structures of the molecules discussed here will provide better activity than the parent molecules themselves. Enzymes like PEAMT1 and PEAMT2, which interact with phosphorylated substrates, bind more tightly to the phosphorylated forms of the substrate than to the non-phosphorylated forms. For example, in the case of SH2 domains, phosphorylated peptides exhibit binding four orders of magnitude greater than non-phosphorylated peptides (Bradshaw et al, (1999) J. Mol. Biol. 293(4):971-85). Therefore, the addition of a phosphate, or a phosphate mimic to the ethanolamine-like compounds will increase the affinity for the enzyme making them more potent inhibitors of the PEAMT enzymes.*] *yes I agree with deleting. Too strong a statement*

Example 5

Table 5: Nematicidal activity of a variety of ethanolamine-like compounds against *C. elegans.*

COMPOUND	CHEMICAL NAME	EC_{50} (mM)
3701 	2-(Diisopropylamino)ethanol	4.7
3702 	2-Benzylaminoethanol	3.4
3703 	2-(tert-Butylamino)ethanol	4.1
3704 	D-Phenylalaninol	2.5
3733 	N-(2-Hydroxyethyl)aniline	4.2
3736	2-4-methoxy-phenylaminoethanesulfonyl	0.5

	fluoride	
3738 	2-4-chlorophenylaminoethanesulfonyl fluoride	0.082
3743 	2,5-Dioxo-1-pyrrolidineethanesulfonyl fluoride	1.3
3745 	2-Benzotriazol-1-yl-ethanesulfonylfluoride	1.7 1.34
3746 	2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride	0.002
3747 	2-Benzoimidazol-1-yl-ethanesulfonyl fluoride	1.4
3754 	2-phenylaminoethanesulfonyl fluoride	0.94 0.57

3755 	2-diisopropylaminoethanesulfonyl fluoride	0.75
3761 	4-N-ethyl-N-methylaminoazobenzene	0.007
3766 	N-ethylaniline	0.36
3767 	2-[4-(4-dimethylamino-phenylazo)-phenylamino]-ethanesulfonyl fluoride	0.007

EC50's of compounds against *C. elegans* were measured in a contact assay. Compounds were solubilized in acetone, ethanol or water (in that order of preference) at 100x the desired concentration. Dilution series of 10x, 3x, 2x or square root-2x were accomplished by serial dilution with identical solvent. Between 6 and 12 concentration

points were assayed. For each concentration, 50 microliters of 100x compound solution were added to 5 ml NGM-agar at 50 to 60 °C. Four wells of a 24-well plate each received approximately 1 ml of the the NGM-agar-compound mixture. Following overnight cooling, 8 microlitres of a fresh culture of OP50 bacteria was added to each well, and this was incubated overnight at room temperature. One L4 stage *C. elegans* hermaphrodite worm (strain N2) was added to each well. Plates were incubated at 20 °C. At 96 hours after worm addition, each well was scored for number of adults, number of eggs and number of larvae present, as well as for presence or absence of crystallized compound, cloudiness of plates, and depletion of bacterial food source. Most plates were also scored at 120 or 144 hours following challenge. For determination of an EC50, the average number of adults present in the 4 replicate wells 96 hours after challenge was determined, and an EC50 interpolated.

Example 6

Greenhouse assay of 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride (3746) and preliminary assessment of non-target effects

As seen in Figure 4, 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride shows nematode control approaching that of the commercial nematicides fenamiphos (Nemacur) in drench (soil based) assays against root knot nematode infections of tomato plants in the greenhouse. Furthermore, 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride shows no phytoxicity at any of the rates tested. Additionally, as is seen in the Table 6 below 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride is not toxic to several arthropods. Low to moderate toxicity is seen with various fungal species. The lack of general (i.e., non-specific) toxicity of 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride is consistent with the killing of C. elegans in vitro and control of M. incognita infection in tomato pot assays being due to inhibition of essential nematode phosphoethanolamine n-methyltransferases. However, it is entirely possible that the compounds elicit their lethat effect through a mechanism that does not entail inhibition of PMEAT.

Table 6: Fungal and arthropod toxicity of 3746

Organism		Concentration (µM)	Result
Fungi	*Sclerotinia sclerotiorum*	163	> 75% growth inhibition
	Sclerotinia sclerotiorum	16.3	< 25% growth inhibition
	Fusarium graminearum	16.3	> 75% growth inhibition
	Fusarium graminearum	1.63	< 25% growth inhibition
	Alternaria solani	16.3	> 75% growth inhibition
	Alternaria solani	1.63	< 25% growth inhibition
	Botrytis cinerea	16.3	> 75% growth inhibition
	Botrytis cinerea	1.63	< 25% growth inhibition
Arthropod	Beet army worm	25000	Lethal
	Beet army worm	2500	No effect
	Corn ear worm	25000	Lethal
	Corn ear worm	2500	Non-effect

C. elegans testing of 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride (3746) and other compounds

Various compounds were tested for nematicidal activity against *C. elegans* using both plate and well assays. The results are presented in the table below. The assays were performed as described below.

C. elegans well assay

I. Dilution of test compounds

The test compounds were solubilized in DMSO at 10 mg/ml to create 100x stock solutions. A dilution series was created by diluting the stock solution with DMSO. For each well assay 4 µl of the appropriate dilution was added to a well of a test plate.

II. Media and bacterial stock

A 400 µl aliquot of bacterial stock (in M9 buffer with ampicillin and nystatin) was added to each well of the test plate. Worms are added and the test plate was placed on a rotary shaker and held at 20 °C. Worms werre examined at 4 hrs and additional timepoints

III. Worms

L1 worms and L4 worms were used in the assay. L1 worms were prepared by plating eggs on a plate without a bacterial feeding layer. The eggs hatched and arrested at the L1 stage. This L1 stage population was used to create a stock for the experiments. To create an L4 stage stock a small number of worms were taken from an overgrown and starved plate of worms and seeded on a plate with a bacterial feeder layer. A 25 μl aliquot of worms was added to each well in the assay.

IV. Scoring:

Worms were scored at 4 hrs, 24 hrs, 48 hrs and 72 hours.

<u>*C. elegans* Agar (plate) assay:</u>

I. Dilution of test compounds

Dilutions of test compounds were prepared as described above for the well assay. An 80 μl of the appropriate dilution was added to a 15 ml tube along with 8 ml of 60 °C NGM agar. The contents of the tube were mixed and divided to two tubes (4 ml each) to create a pair of test plates.

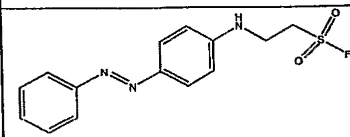
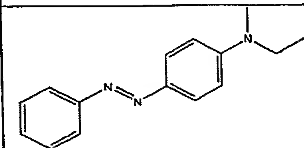
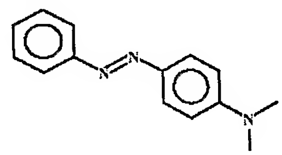
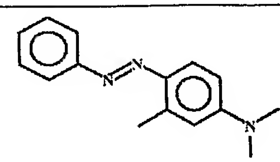
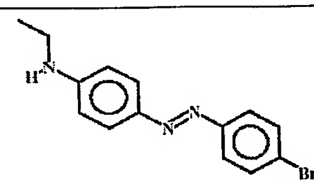
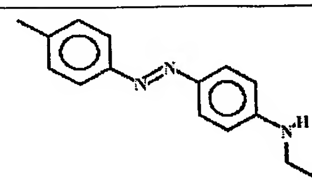
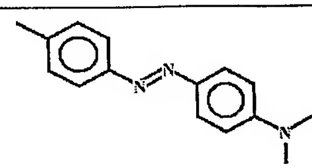
II. Bacteria

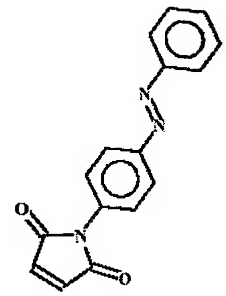
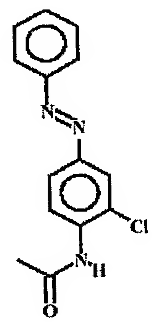
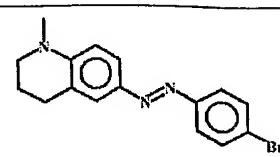
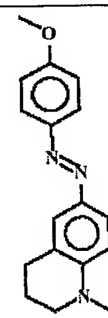
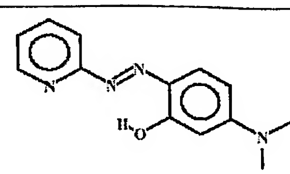
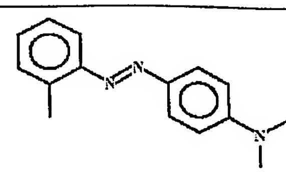
A 25 μl aliquot of a freshly grown bacterial culture was spotted in each plate as a feeder layer.

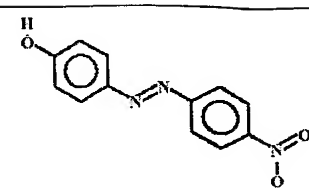
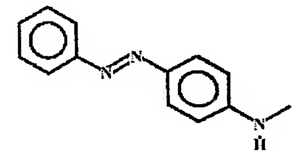
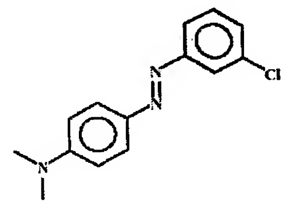
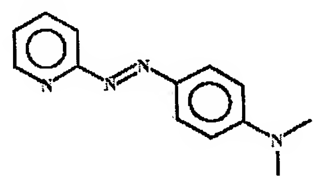
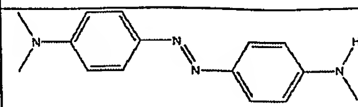
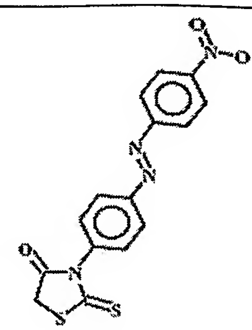
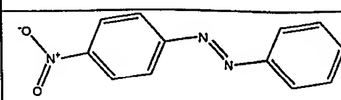
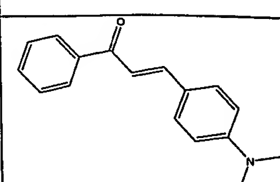
III. Worms

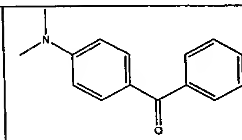
Worms were prepared as described above. One plate from each pair received 10-20 eggs and the other plate received a single L4 worm. Plates were incubated at A 20 °C and scored at at 4 hrs, 24 hrs, 48 hrs and 72.

Well and plate EC_{50} values reported in table below are in μg/ml.

	LogP	Mol wt	Well IC_{50} µg/ml	Plate IC_{50} µg/ml	Structure
DC3746	3.98	307.3	6.3-12.5	1.6	
DC3761	4.61	239.3	6.3-12.5	0.8	
DC3783	4.46	225.29	0.4-0.78	1.6	
DC3787	4.96	239.32	0.4-0.78	1.6	
DC3800	5.53	304.19	0.2-0.4	0.4	
DC3801	5.17	239.32	0.2-0.4	0.4	
DC3785	4.96	239.32	6.3-12.5	WT	

DC3792	3.59	277.28	3.2-6.3	WT	
DC3796	3.49	273.72	3.2-6.3	6.3	
DC3819	5.99	330.23	0.4-0.8	0.8	
DC3821	5.15	281.36	0.8-1.6	1.6	
DC3829	2.78	242.28	6.2-12.5	3.2	
DC3832	4.96	239.32	1.5-3.1	1.6	

DC3844	3.70	243.22	3.1-6.2	6.25	
DC3845	4.14	211.27	0.4-0.8	0.4	
DC3853	5.17	259.74	0.4	0.4	
DC3791	3.03	226.28	25-50	12.5-25	
DC3775	4.44	254.34	0.8	0.4	
DC3833	3.41	358.39	12.5-25	6.2	
DC3898	3.59	227.22	1.6	ND	
DC3901	3.79	251.33	12.5	ND	

DC3890	3.66	225.29	25	ND	

Example 8

<u>*M. incognita* testing of 2-(4-phenylazo-phenylamino)-ethanesulfonyl fluoride (3746) and other compounds in a miniaturized greenhouse assay</u>

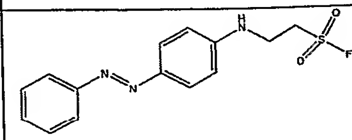
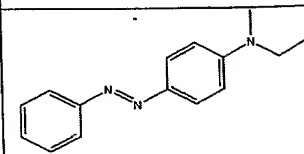
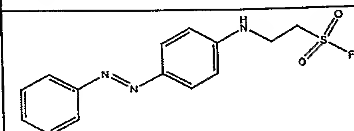
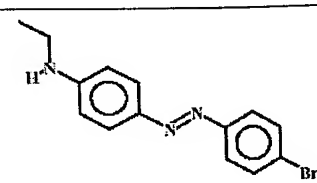
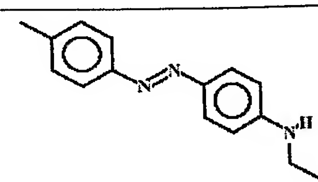
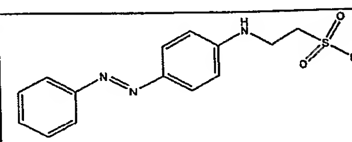
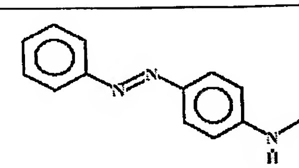
Overview

Sand in a glass vial is drenched with an acetone solution containing the test compound and then allowed to dry. A sprouted cucumber seedling is placed into the dry sand and then water is added immediately. The next day *Meloidogyne incognita* J2 larvae are added to the vials and 10 days later the roots are evaluated for nematode galling.

Procedure

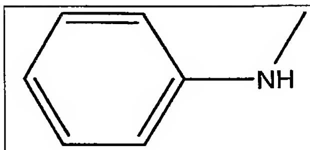
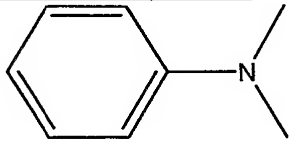
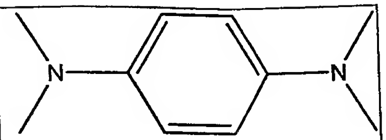
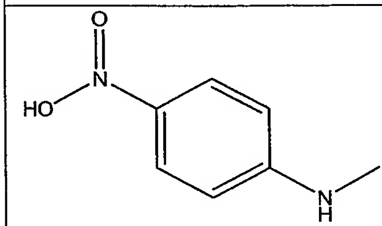
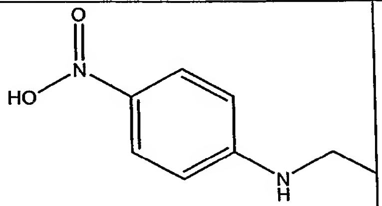
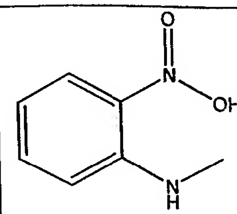
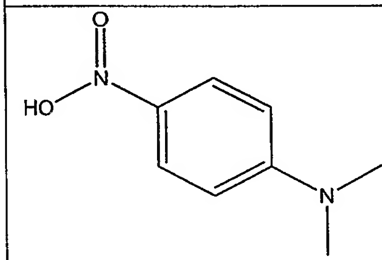
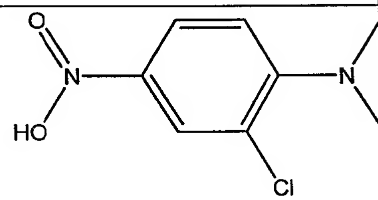
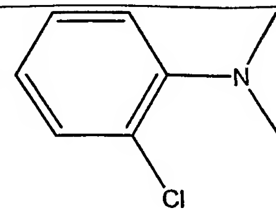
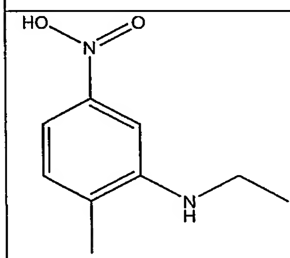
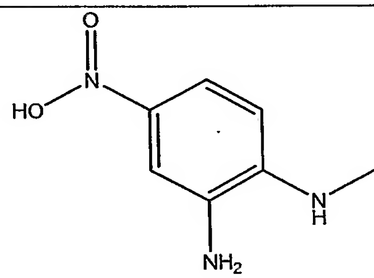
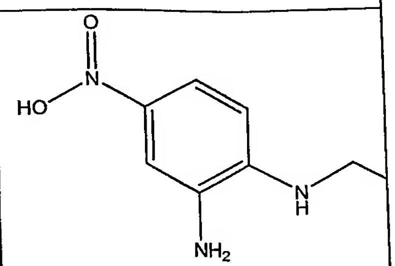
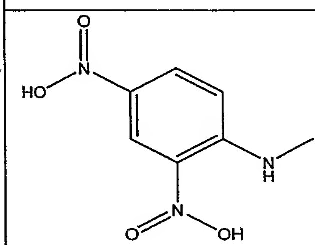
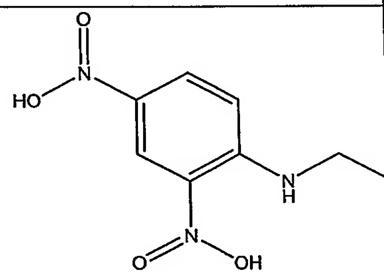
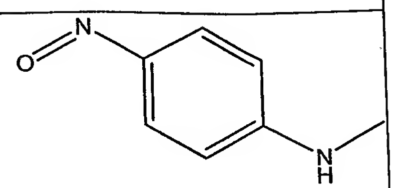
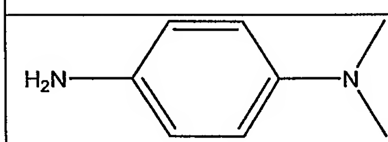
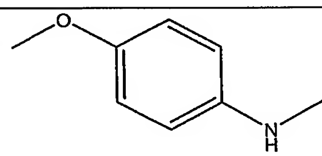
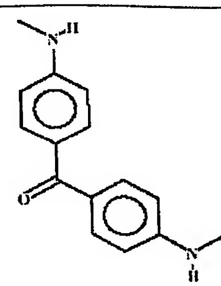
Cucumber seeds are sprouted for 3 days in moist paper towels. Acceptable sprouts should be 3-4 cm long with several lateral roots just emerging. Stock solutions are prepared in acetone (16.5 mg of compound in 10 ml acetone); or DMSO (10 mg of compound in 1 ml DMSO). Add 20 ml of dry sand to each vial, cap, and shake vigorously. Uncap and place in hood to evaporate off acetone (6-24 hours). Shake well when dry. Plant seedlings: slant vial, lay in seedling in correct orientation and so that cotyledons will be just above sand, then tilt back to cover radicle with sand. Add 3.3 ml water to each vial and place the vial racks under the fluorescent light racks. Inoculate the day after planting. Add 500 *M. incognita* J2 larvae to each vial in 200-300 μl of deionized or spring water. Place the vials back under the fluorescent lamps at ambient room temperature and water as needed with 300 ul deionized water, usually twice during duration of test. Harvest 10 days after inoculation by washing sand off the roots. Record fresh plant weight and assign a root gall rating and phytotoxicity rating using the following scales: Gall rating scale (Gall: % root mass galled): 0 = 0%; 1 = 1-20%; 2 = 21-50%; and 3 = 51-100%. Phytotoxicity scale (Ptox; % plant weight reduction): 0 = 0%; 1 = 1-20%; 2 = 21-50%; and 3 = 51-100%. Gall 200, Gall 40, Ptox 200 and Ptox 40 are gall ratings at 200 ppm and 40 ppm and phytotoxicity ratings at

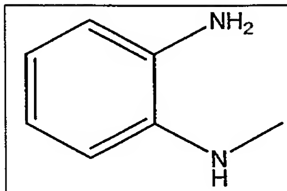
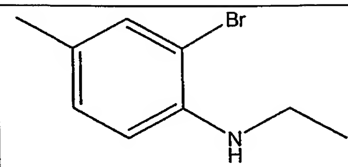
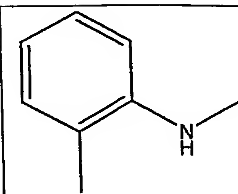
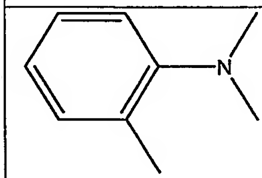
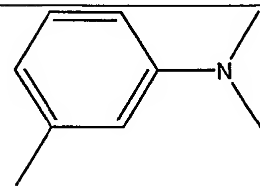
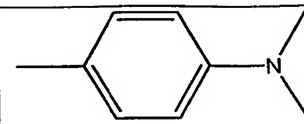
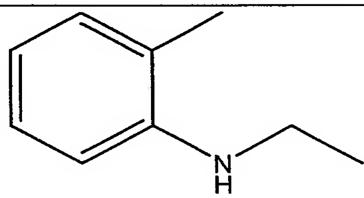
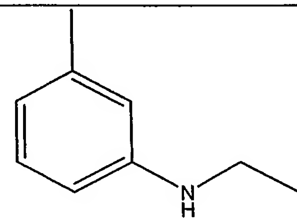
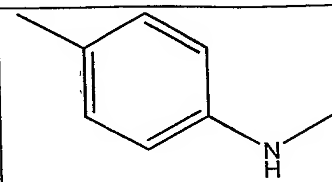
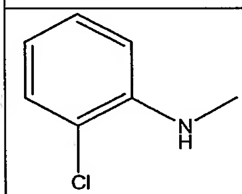
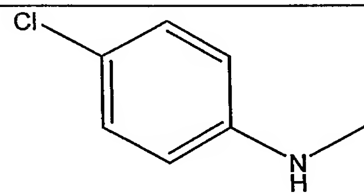
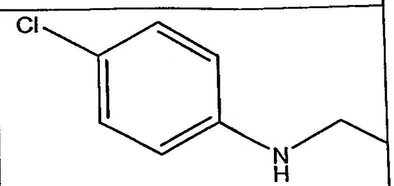
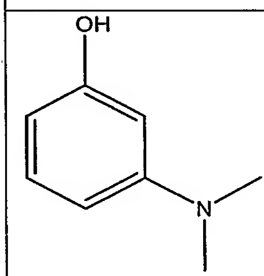
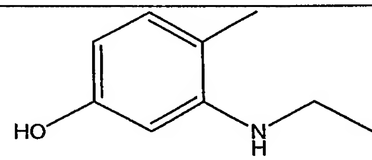
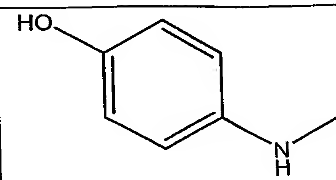
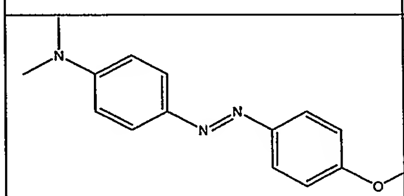
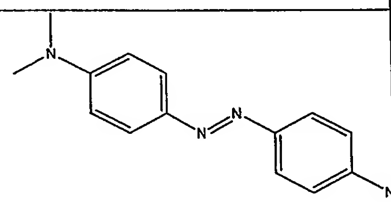
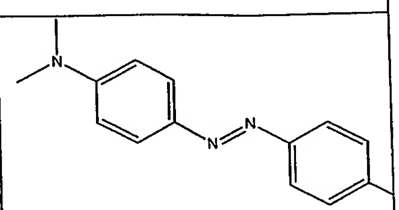
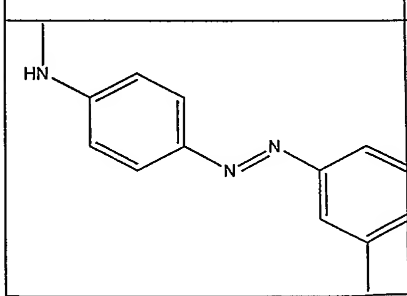
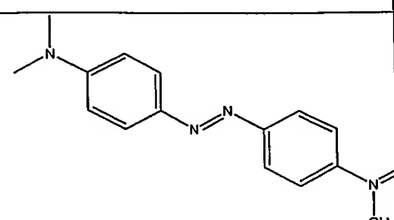
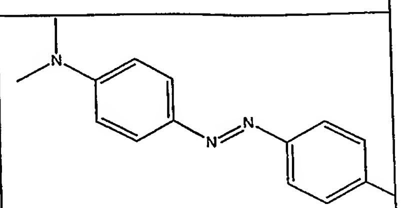
200 ppm and 40 ppm, respectively. The results are reported below. Rows with the same superscript (e.g., a, b or c) correspond to compounds assayed in the same test.

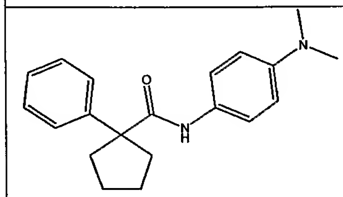
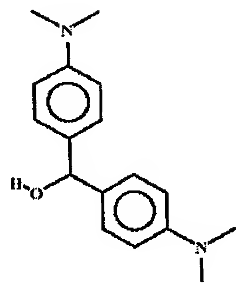
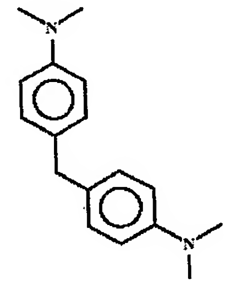
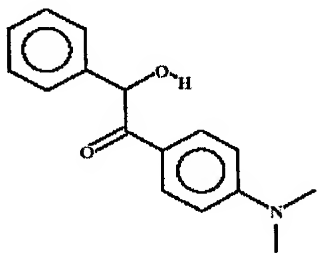
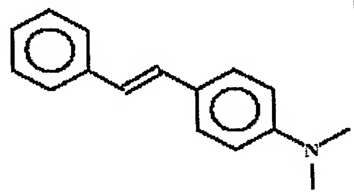
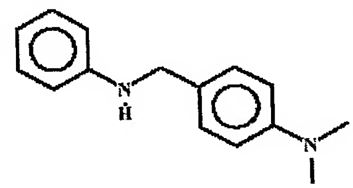
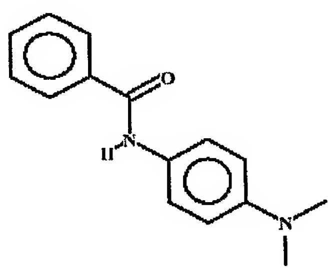
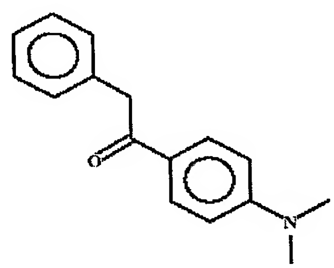
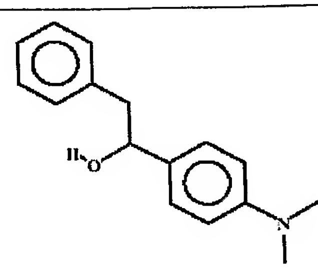
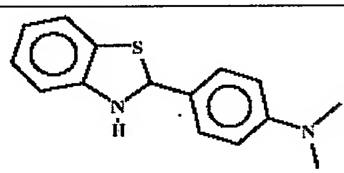
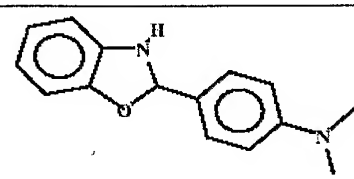
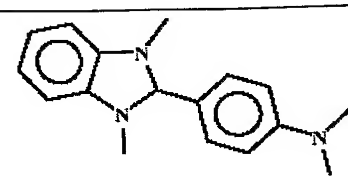
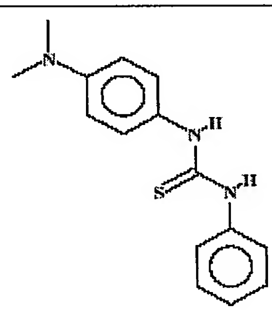
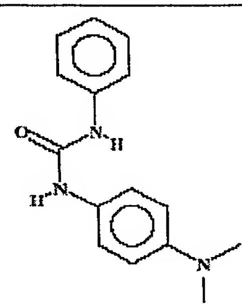
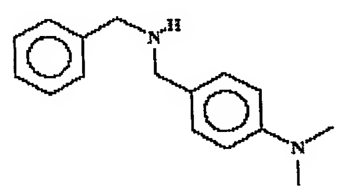
	Gall 200	Gall 40	Ptox 200	Ptox 40	Structure
DC3746[a]	0.00	1.33	2.67	2.33	
DC3761[a]	0.00	0.67	1.00	0.00	
DC3746[b]	0.00	2.00	3.00	1.67	
DC3800[b]	0.00	1.33	2.67	0.00	
DC3801[b]	0.00	1.33	3.00	1.67	
DC3746[c]	0.00	1.33	3.00	1.00	
DC3845[c]	0.00	0.33	3.00	1.00	

Example 9

Additional compound of interest as pesticidal agents:

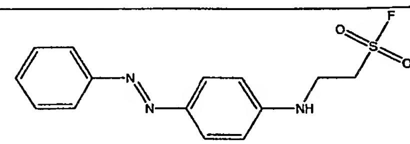
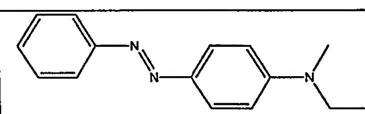
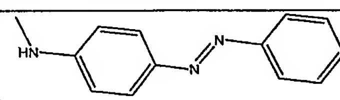
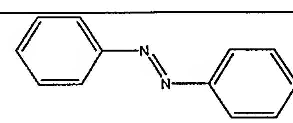
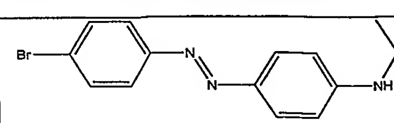
		
		
		
		
		
		
		

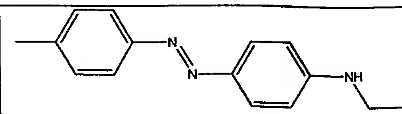
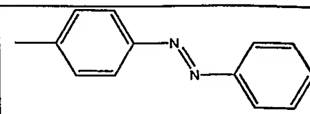
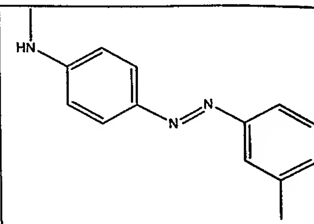
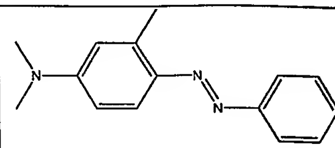
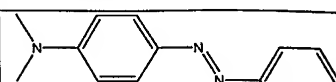
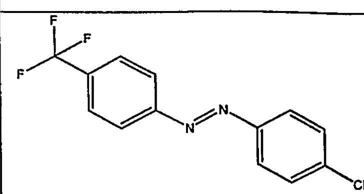
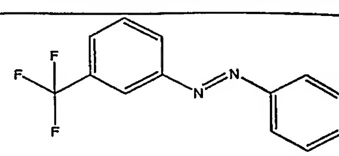
		
		
		
		
		

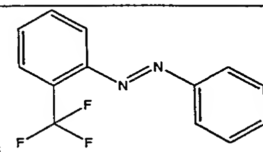
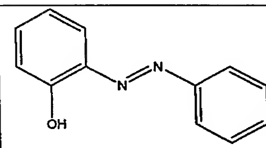
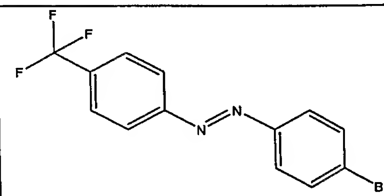
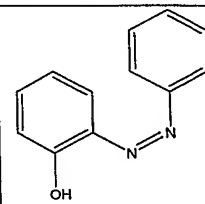
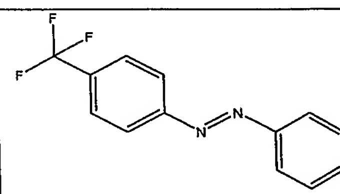
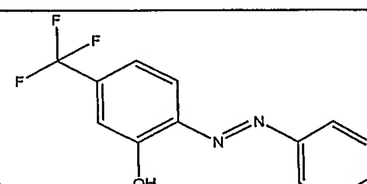
Example 10:

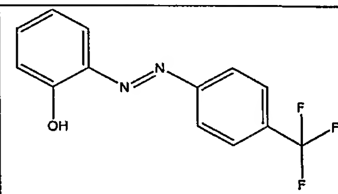
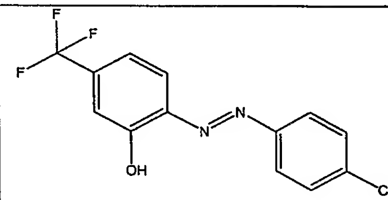
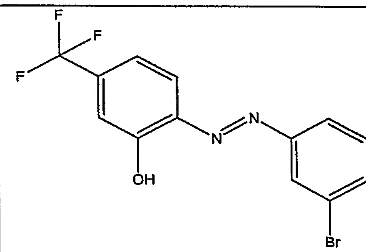
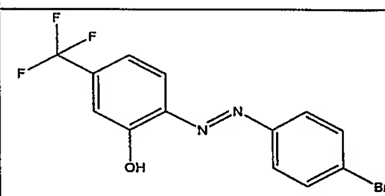
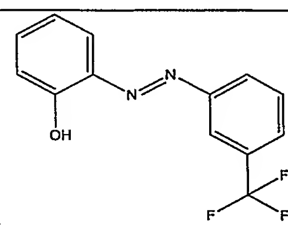
<u>Azobenzenes, nitrobenzenes, stilbenes, and chalcones having nematicidal activity</u>

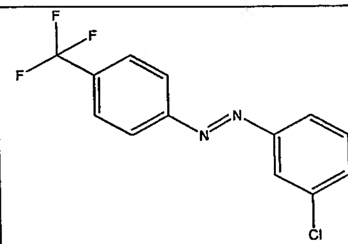
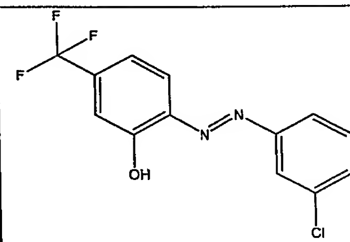
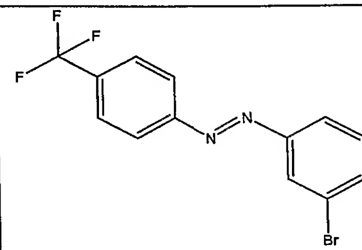
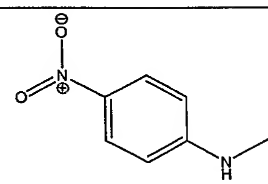
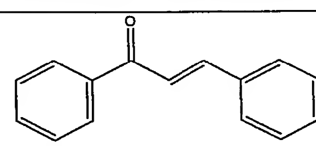
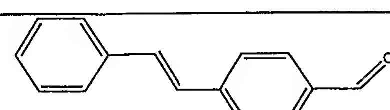
Various azobenzenes, nitrobenzenes, stilbenes, and chalcones were tested for their effectiveness against: *Meloidogyne incognita* infecting tomatoes growing in a greenhouse (Tomatoes/Greehouse; 21 days); *Meloidogyne incognita* infecting cucumber growing a laboratory (Cucumber/Laboratory; 10 days); and *Meloidogyne incognita* in an *in vitro* well assay (*In vitro*; 4 days). The results of these studies are presented in the table below. A "+" indicates strong efficacy of the compound; "-" indicates weak efficacy of the compound; and "+/-" indicates intermediate or variable efficacy.

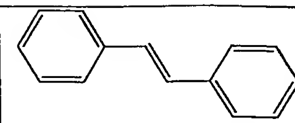
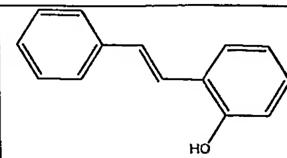
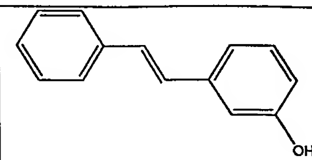
Name	Tomato Greenhouse	Cucumber Laboratory	*In vitro*	Structure Name
DC3746	+	+	+	 (E)-2-(4-(phenyldiazenyl)phenylamino)ethanesulfonyl fluoride
DC3761	+	+	+	 (E)-N-ethyl-N-methyl-4-(phenyldiazenyl)aniline
DC3845	+	+	+	 (E)-N-methyl-4-(phenyldiazenyl)aniline
DC3854	+	+	+/-	 (E)-1,2-diphenyldiazene
DC3800	+	+	+	

				(E)-4-((4-bromophenyl)diazenyl)-N-ethylaniline
DC3801	+	+	+	 (E)-N-ethyl-4-(p-tolyldiazenyl)aniline
DC3938	+	+	-	 (E)-1-phenyl-2-p-tolyldiazene
DC3881	+/-	+/-	+	 (E)-N-methyl-4-(m-tolyldiazenyl)aniline
DC3787	+	-	+/-	 (E)-N,N,3-trimethyl-4-(phenyldiazenyl)aniline
DC3783	+/-	+/-	+/-	 (E)-N,N-dimethyl-4-(phenyldiazenyl)aniline
DC4293	+/-	+/-	-	 (E)-1-(4-chlorophenyl)-2-(4-(trifluoromethyl)phenyl)diazene
DC4294	-	-	-	 (E)-1-phenyl-2-(3-

				(trifluoromethyl)phenyl)diazene
DC4295	-	+/-	+/-	 (E)-1-phenyl-2-(2-(trifluoromethyl)phenyl)diazene
DC4296 *	+	+	+	 (E)-2-(phenyldiazenyl)phenol
DC4297	-	-	+/-	 (E)-1-(4-bromophenyl)-2-(4-(trifluoromethyl)phenyl)diazene
DC4298 *	+	+/-	+/-	 (Z)-2-(phenyldiazenyl)phenol
DC4299	+	+/-	-	 (E)-1-phenyl-2-(4-(trifluoromethyl)phenyl)diazene
DC4350	+	-	-	 (E)-2-(phenyldiazenyl)-5-

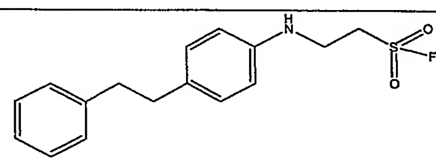
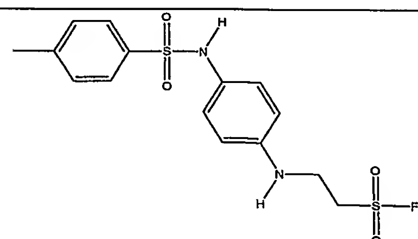
				(trifluoromethyl)phenol
DC4351	+	+/-	-	 (E)-2-((4-(trifluoromethyl)phenyl)diazenyl)phenol
DC4352	-	-	-	 (E)-2-((4-chlorophenyl)diazenyl)-5-(trifluoromethyl)phenol
DC4353	-	-	-	 (E)-2-((3-bromophenyl)diazenyl)-5-(trifluoromethyl)phenol
DC4354	-	-	-	 (E)-2-((4-bromophenyl)diazenyl)-5-(trifluoromethyl)phenol
DC4355	+	-	-	 (E)-2-((3-(trifluoromethyl)phenyl)diazenyl)phenol

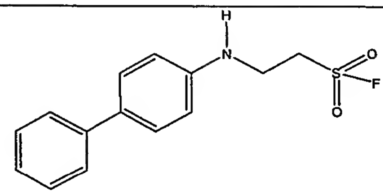
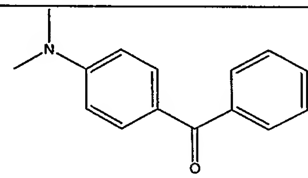
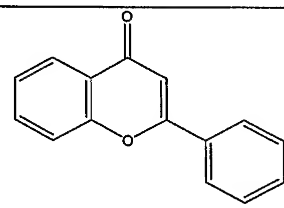
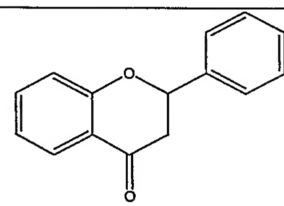
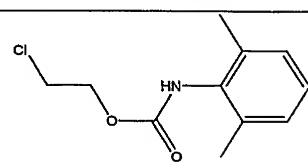
DC4356	+	+/-	-	 (E)-1-(3-chlorophenyl)-2-(4-(trifluoromethyl)phenyl)diazene
DC4357	+	-	-	 (E)-2-((3-chlorophenyl)diazenyl)-5-(trifluoromethyl)phenol
DC4358	+	-	-	 (E)-1-(3-bromophenyl)-2-(4-(trifluoromethyl)phenyl)diazene
DC3859	+/-	+	+	 N-methyl-4-nitroaniline
DC3964	+	+/-	+	 (E)-chalcone
DC3923	+/-	+	-	 (E)-4-styrylbenzaldehyde

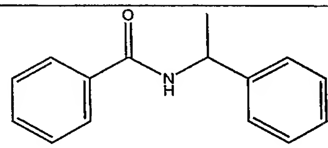
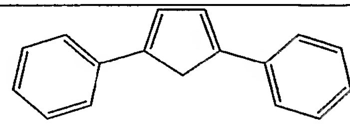
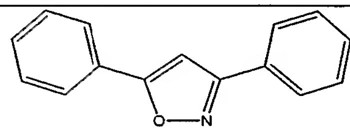
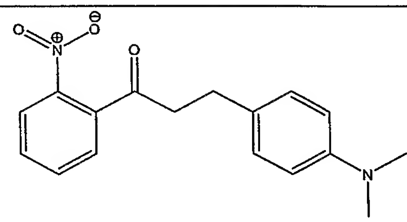
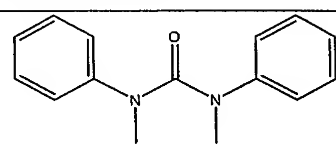
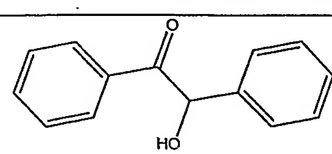
DC3855	-	+/-	-	 (E)-1,2-diphenylethene
DC4186	-	+/-	+	 (E)-2-styrylphenol
DC4191	-	+	+/-	 (E)-3-styrylphenol

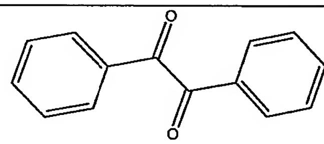
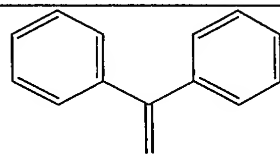
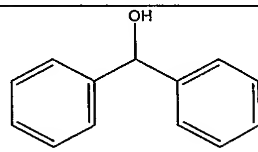
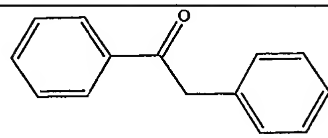
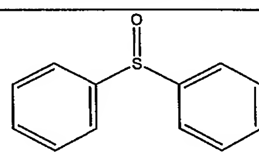
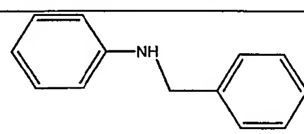
Ezample 11

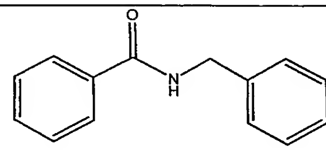
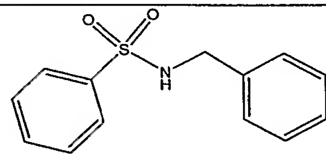
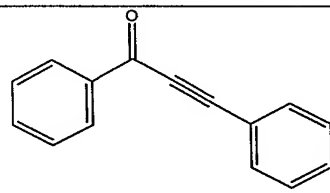
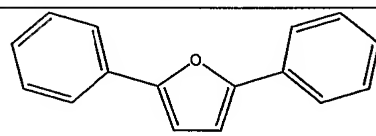
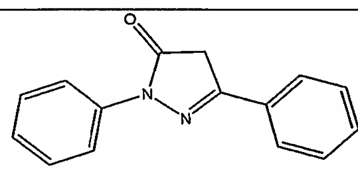
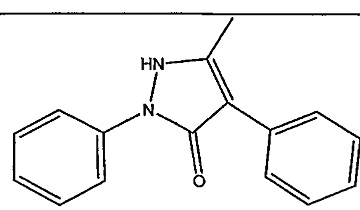
Additional compounds of interest as pesticidal agents.

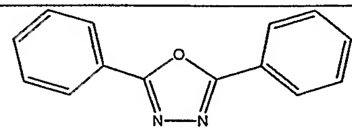
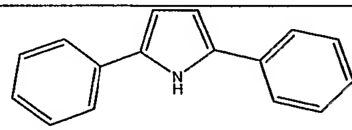
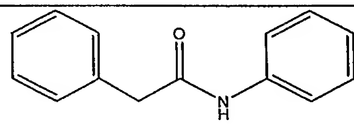
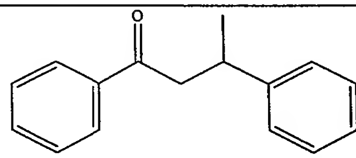
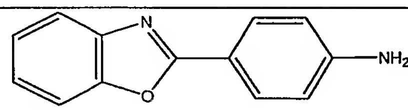
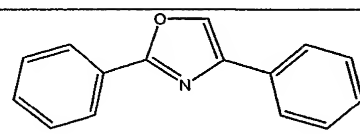
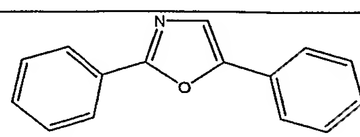
Name	Structure Name
DC3778	 2-(4-phenethylphenylamino)ethanesulfonyl fluoride
DC3781	

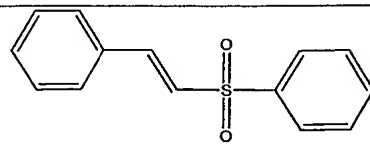
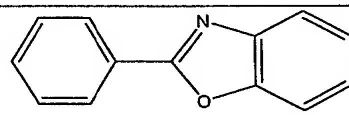
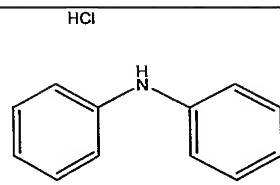
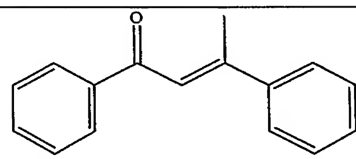
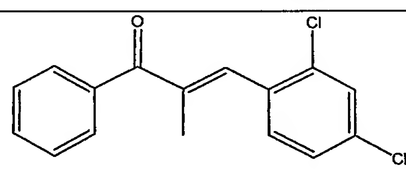
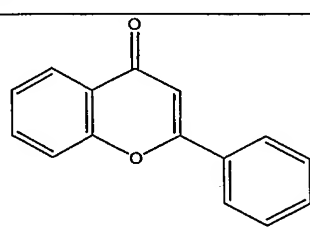
	2-(4-(4-methylphenylsulfonamido)phenylamino)ethanesulfonyl fluoride
DC3782	 2-(biphenyl-4-ylamino)ethanesulfonyl fluoride
DC3890	 (4-(dimethylamino)phenyl)(phenyl)methanone
DC3960	 2-phenyl-4H-chromen-4-one
DC3962	 2-phenylchroman-4-one
DC3980	 2-chloroethyl 2,6-dimethylphenylcarbamate

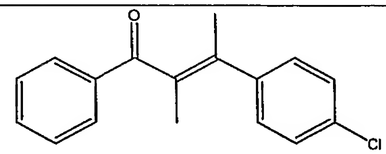
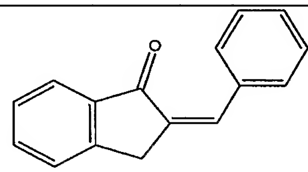
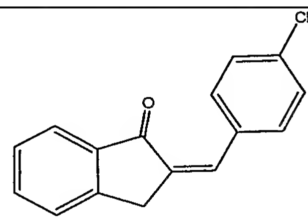
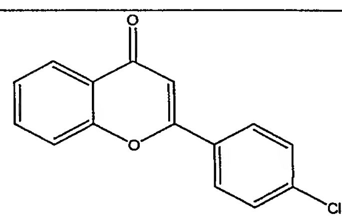
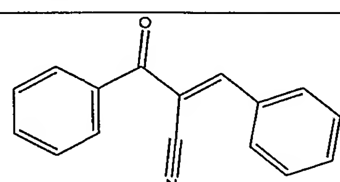
DC4039	 N-(1-phenylethyl)benzamide
DC4051	 1,4-diphenylcyclopenta-1,3-diene
DC4053	 3,5-diphenylisoxazole
DC4144	 3-(4-(dimethylamino)phenyl)-1-(2-nitrophenyl)propan-1-one
DC4152	 1,3-dimethyl-1,3-diphenylurea
DC4153	 2-hydroxy-1,2-diphenylethanone

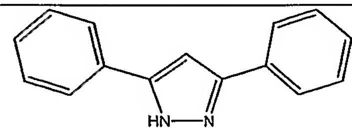
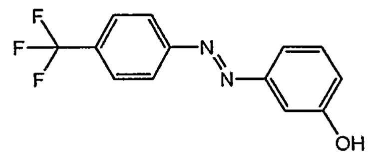
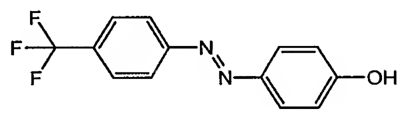
DC4154	 benzyl
DC4155	 ethene-1,1-diyldibenzene
DC4157	 Diphenylmethanol
DC4163	 1,2-diphenylethanone
DC4167	 Sulfinyldibenzene
DC4171	 N-benzylaniline

DC4176	 N-benzylbenzamide
DC4178	 N-benzylbenzenesulfonamide
DC4180	 1,3-diphenylprop-2-yn-1-one
DC4182	 2,5-diphenylfuran
DC4187	 1,3-diphenyl-1H-pyrazol-5(4H)-one
DC4197	

	5-methyl-2,4-diphenyl-1H-pyrazol-3(2H)-one
DC4217	 2,5-diphenyl-1,3,4-oxadiazole
DC4219	 2,5-diphenyl-1H-pyrrole
DC4223	 N,2-diphenylacetamide
DC4231	 1,3-diphenylbutan-1-one
DC4236	 4-(benzo[d]oxazol-2-yl)aniline
DC4265	 2,4-diphenyloxazole
DC4271	

	2,5-diphenyloxazole
DC4272	 (E)-(2-(phenylsulfonyl)vinyl)benzene
DC4273	 2-phenylbenzo[d]oxazole
DC4280	 Diphenylamine
DC4284	 (E)-1,3-diphenylbut-2-en-1-one
DC4285	 (E)-3-(2,4-dichlorophenyl)-2-methyl-1-phenylprop-2-en-1-one
DC4286	

	2-phenyl-4H-chromen-4-one
DC4287	 (E)-3-(4-chlorophenyl)-2-methyl-1-phenylbut-2-en-1-one
DC4288	 (Z)-2-benzylidene-2,3-dihydro-1H-inden-1-one
DC4289	 (Z)-2-(4-chlorobenzylidene)-2,3-dihydro-1H-inden-1-one
DC4290	 2-(4-chlorophenyl)-4H-chromen-4-one
DC4291	

	(E)-2-benzoyl-3-phenylacrylonitrile
DC4292	 3,5-diphenyl-1H-pyrazole
DC4362	 3-((4-(trifluoromethyl)phenyl)diazenyl)phenol
DC4361	 4-((4-(trifluoromethyl)phenyl)diazenyl)phenol

Example 12:

Non-mutagenic azobenzenes having nematicidal activity

Azobenzenes analogs do not in general show significant acute mammalian toxicity. However, mutagenicity is often seen with this class of chemistry and in one published study the aromatic azo group was associated with mutagenicity – the ability to cause errors in DNA replication – in 77% of molecules surveyed (J Med Chem. 2005 48(1):312-20). Non-mutagenic pesticidal analogs are desireable for both human and animal health and crop chemistry applications.

The most commonly used mutagenicity assay is the Ames test which looks for reverse mutations in histidine-requiring strains of *Salmonella typhimurium*. This procedure evaluates the mutagenic potential of test chemicals by their effect on histidine requiring strains of the bacterium in the absence and presence of a rat liver metabolising systems (S9 extract). When the bacterial cultures are exposed to mutagens some of the bacteria undergo genetic changes resulting in reversion of the bacteria to a non-histidine-

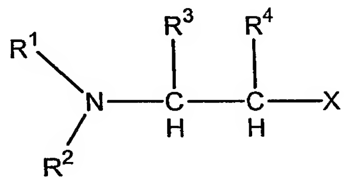
requiring state. The reverted bacteria will then grow in the absence of exogenous histidine thus providing an indication of the potential of the chemical to cause mutation. Commonly used salmonella strains often have additional mutations to increase their sensitivity to mutational effects including error-prone DNA repair systems (e.g., the loss of the excision repair system) and the loss of the lipopolysaccharide barrier that coats the surface of the bacteria.

The COOH and SO_3H substitutents are two electron withdrawing groups that deactivate azobenzene mutagenicity. However the COOH and SO_3H groups have a net negative charge at pH 7 which will tend to impede cellular and transcuticular and uptake (Mol Biochem Parasitol. 1990 41(2):153-65). We surveyed a number of other electron withdrawing groups and determined that some such as the CF_3 group are general (i.e., position independent) deactivators of the azobenzene mutagenicity. In addition to COOH, SO_3H and CF_3 these deactivating groups include but are not limited to $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$.

Three CF_3 containing azobenzenes (DC4299, DC4350, DC4356) have been tested in the Ames assay using the TA98 (frame-shift mutations) and TA100 (point mutation) tester strains. Compounds were dissolved in a dimethylsulfoxide (DMSO) vehicle and tested in duplicate at the concentrations 1.5, 5, 15, 50, 150, 500, 1500 and 5000 ug/plate. DC4299, DC4350 and DC4356 were all Ames negative (i.e., non-mutagenic) either with or without rat liver S9 activation.

WHAT IS CLAIMED IS:

1. A pesticidal composition, comprising an effective amount of a compound of Formula (I) or a salt thereof,



Formula (I)

wherein,

each R^1 and R^2 are independently H, alkyl, oxo, COR^7, cyclyl, cyclylalkyl, heterocyclyl, heterocylylalkyl, aryl, arylalkyl, heteroaryl, or heteroarylalkyl; or R^1 and R^2, taken together with the nitrogen to which they are attached, form a heterocyclic ring;

each R^3 and R^4 are independently H, alkyl, aryl, arylalkyl, heteroaryl, or heteroarylalkyl;

X is H, -OH, $-OPO_3(R^5)_2$, $-PO_3(R^5)_2$, $-CH_2PO_3H_2$, $-SO_3R^5$, SO_2F, SO_2NH_2, SO_2R^5; CO_2H, CO_2R^5, $OC(O)NR^6$, or OCO_2R^5;

each R^5 and R^6 is independently H, alkyl, or haloalkyl; and

each R^7 is independently H, alkyl, hydroxy, or alkoxy.

2. The pesticidal composition of claim 1, wherein each R^1 and R^2 are independently H, alkyl, aryl, or arylalkyl.

3. The pesticidal composition of claim 2, wherein each R^1 and R^2 are independently H, methyl, isopropyl, phenyl, or benzyl.

4. The pesticidal composition of any of claims 1-3, wherein each R^3 and R^4 are independently H, alkyl, or arylalkyl.

5. The pesticidal composition of any of claims 1-4, wherein, each R^3 and R^4 are independently H.

6. The pesticidal composition of any of claims 1-4, wherein R^3 is benzyl and R^4 is H.

7. The pesticidal composition of any of claims 1-6, wherein X is H, -OH, -OPO_3H_2, -PO_3H_2, -$CH_2PO_3H_2$, -SO_3H, or SO_2F.

8. The pesticidal composition of any of claims 1-5, formula (I), wherein
each R^1 and R^2 are independently H, alkyl, aryl, or arylalkyl;
each R^3 and R^4 are independently H, alkyl, or arylalkyl; and
X is H, -OH, -OPO_3H_2, -PO_3H_2, -$CH_2PO_3H_2$, -SO_3H, or SO_2F.

9. The pesticidal composition of any of claims 4-6, wherein each R^1 and R^2 are independently H, alkyl, aryl, or arylalkyl.

10. The pesticidal composition of claim 9, wherein each R^1 and R^2 are independently H, methyl, isopropyl, phenyl, or benzyl.

11. The pesticidal composition of claim 8, wherein each R^3 and R^4 are independently H.

12. The pesticidal composition of claim 11, wherein R^3 is benzyl and R^4 is H.

13. The pesticidal composition of claim 1, wherein the compound of formula (I) has a molecular weight of less than 500 Daltons.

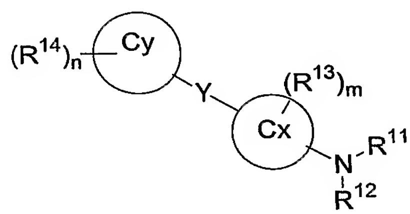
14. The pesticidal composition of claim 1, wherein the compound of formula (I) comprises at least one I or Br.

15. A compound selected from the group consisting of 2-Amino-ethanol, 2-Methylamino-ethanol, 2-Dimethylamino-ethanol, choline chloride, phosphoric acid mono-(2-amino-ethyl) ester, 2-Amino-ethanesulfonic acid, (3-Amino-propyl)-

phosphonic acid, 2-Diisopropylamino-ethanol, 2-tert-Butylamino-ethanol, 2-Amino-3-phenyl-propan-1-ol, 2-Phenylamino-ethanol, 2-Phenylamino-ethanesulfonic acid, 2-Amino-1-phenyl-ethanol, 2-Benzylamino-ethanol, or 2-Diisopropylamino-ethanesulfonyl fluoride.

16. A method for control of unwanted nematodes or apicomplexan parasites, the method comprising administering to vertebrates, plants, seeds or soil a pesticidal composition of claim 1.

17. A pesticidal composition, comprising an effective amount of a compound of Formula (IIa) or a salt thereof,



Formula (IIa)

wherein,

R^{11} and R^{12} are independently H, hydroxy, oxo, alkyl, haloalkyl, sulfonyl, aminosulfonylalkyl, halosulfonylalkyl, or C(O)R^{17}; or R^{11} and R^{12}, together with the nitrogen to which they are attached, form a heterocyclyl or heteroaryl ring; or one of R^{11} or R^{12}, together with R^{13} and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring; each R^{11} and R^{12} can independently be substituted by one or more R^{15};

each R^{13} is independently halo, C(O)R^{17}, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, or alkyl; each of which is optionally substituted with 1-4 R^{16};

each R^{14} is independently halo, C(O)R^{17}, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl, cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{16};

m and n are independently 0-4;

each R^{15} is independently alkyl, C(O), or C(S);

each R^{16} is independently alkyl, or $C(O)R^{17}$; Cx or Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Y is -N=N-, $-C(R^{17})=C(R^{17})-$, $-C(O)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(O)-$, $-C(OH)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(OH)-$, $-CH_2CH_2-$, -C≡C-, -CH(OH)-, $-CH_2-$, -C(O)-, $-C(O)CH_2-$, $-CH_2C(O)-$, -C(O)CH(OH)-, -CH(OH)C(O)-, $-CH_2N(R^{18})-$, $-N(R^{18})CH_2-$, $-CH_2N(R^{18})CH_2-$, $-CH_2CH_2N(R^{18})-$, $-N(R^{18})CH_2CH_2-$, $-CH_2OCH_2-$, $-CH_2CH_2O-$, $-OCH_2CH_2-$, $-CH_2S(O)_qCH_2-$, $-CH_2CH_2S(O)_q-$, $-S(O)_qCH_2CH_2-$, $-C(O)N(R^{18})-$, $-N(R^{18})C(O)-$, $-N(R^{18})C(O)N(R^{18})-$, $-N(R^{18})C(S)-N(R^{18})-$, $-CH(OH)CH_2-$, $-CH_2CH(OH)-$, -CH=CH-, $-S(O)_qN(R^{18})-$, $-C(O)N(R^{18})C(R^{17})_2$, $-C(O)CH_2CH_2-$, -C(O)C(O)-, -C(C)-, -S(O)-, -, $S(O)_qN(R^{18})C(R^{17})_2$, $-C(O)CH_2C(R^{17})-$, $- CH_2C(O)C(R^{17})-$, $-CHCHS(O)_q-$, $NR^{18}-$, or – $C(O)C(R^{17})C(R^{17})-$;

q is 0, 1, or 2;

each R^{17} is independently H, alkyl, haloalkyl, hydroxy, or alkoxy; and

each R^{18} is independently H or alkyl.

18. The composition of claim 17, wherein Cx or Cy is pyridyl.

19. The composition of claim 17 or 18, wherein Cx or Cy is phenyl.

20. The composition of any of claims 17-19, wherein Cx is phenyl and Cy is phenyl or pyridyl.

21. The composition of any of claims 17-20, wherein Cx is phenyl and $NR^{11}R^{12}$ is positioned para to Y.

22. The composition of any of claims 17-21, wherein

R^{11} is H, alkyl, fluoroalkyl or oxo; or when taken together with R^{12} and the nitrogen to which it is attached, forms a heterocyclyl or heteroaryl ring; or when taken together with R^{13} and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring; and

R^{12} is H, alkyl, fluoroalkyl, hydroxy, halosulfonylalkyl, -C(O)R^{17}, or when taken together with R^{12} and the nitrogen to which it is attached, forms a heterocyclyl or heteroaryl ring; or when taken together with R^{13} and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring.

23. The composition of any of claims 17-21, wherein R^{11} is H and R^{12} is fluorosulfonylalkyl.

24. The composition of any of claim 17-21, wherein R^{12} is flourosulfonylethyl.

25. The composition of any of claims 17-21, wherein R^{12} is -C(O)CH_3.

26. The composition of any of claims 17-21, wherein, R^{11} is taken together with R^{12} and the nitrogen to which they are attached to form a heterocyclyl.

27. The composition of any of claims 17-21, wherein R^{11} is taken together with R^{13} and the nitrogen to which it is attached to form a heterocyclyl.

28. The composition of any of claims 17-21, wherein R^{11} and R^{12}, together with the nitrogen to which they are attached are nitro.

29. The composition of any of claims 17-21, wherein each R^{11} and R^{12} are independently H, alkyl or fluoroalkyl.

30. The composition of any of claims 17-21, wherein R^{11} is H and R^{12} is methyl or ethyl.

31. The composition of any of claims 17-21, wherein R^{11} and R^{12} are both alkyl or both fluoralkyl.

32. The compsition of any of claims 17-21, wherein R^{11} is methyl and R^{12} is methyl or ethyl.

33. The composition of any of claims 17-32, wherein m is 0.

34. The composition of any of claims 17-32, wherein
m is 1; and
R^{13} is alkyl, haloalkyl, sulfonyl, alkoxy, hydroxy, halo.

35. The composition of any of claims 17-32, wherein R^{13} is methyl, trifluoromethyl, hydroxy, or chloro.

36. The composition of any of claims 17-32, wherein n is 0.

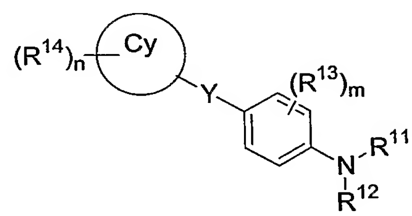
37. The composition of any of claims 17-32, wherein
n is 1; and
R^{14} is halo, alkyl, haloalkyl, hydroxy, alkoxy, amino, or nitro.

38. The composition of any of claims 17-37, wherein Y is -N=N-, -CR^{17}=CR^{17}-, -C(O)CR^{17}=CR^{17}-, -CR^{17}=CR^{17}C(O)-, -C(OH)CR^{17}=CR^{17}-, -CR^{17}=CR^{17}C(OH)-, -CH(OH)-, or -C(O)-.

39. The composition of claim 38, wherein Y is -N=N-, or -CR^{17}=CR^{17}-.

40. The composition of any of claims 17-21, wherein
R^{11} is H, alkyl, haloalkyl or oxo;
R^{12} is H, alkyl, haloalkyl or hydroxy;
R^{13} is alkyl, haloalkyl, aminohaloalkyl, sulfonyl, alkoxy, hydroxy, or halo;
R^{14} is halo, alkyl, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, or nitro;
m and n are each independently 0 or 1; and
Y is -N=N-, -CR^{17}=CR^{17}-, -C(O)CR^{17}=CR^{17}-, -CR^{17}=CR^{17}C(O)-, -C(OH)CR^{17}=CR^{17}-, -CR^{17}=CR^{17}C(OH)-, -CH(OH)-, or -C(O)-.

41. A pesticidal composition, comprising an effective amount of a compound of Formula (IIb) or a salt thereof



Formula (IIb)

wherein,

each R^{11} and R^{12} is independently H, hydroxy, oxo, alkyl, haloalkyl, sulfonyl, aminosulfonylalkyl, halosulfonylalkyl, or $C(O)R^{17}$; or R^{11} and R^{12}, together with the nitrogen to which they are attached, form a heterocyclyl or heteroaryl ring; or one of R^{11} or R^{12}, together with R^{13} and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring; each R^{11} and R^{12} can independently be substituted by one or more R^{15};

each R^{13} is independently halo, $C(O)R^{17}$, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, or alkyl; each of which is optionally substituted with 1-4 R^{16};

each R^{14} is independently halo, $C(O)R^{17}$, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl, cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{16};

each m and n are independently 0-4;

each R^{15} is independently alkyl, C(O), or C(S);

each R^{16} is independently alkyl, or $C(O)R^{17}$;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Y is -N=N-, $-C(R^{17})=C(R^{17})-$, $-C(O)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(O)-$, $-C(OH)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(OH)-$, $-CH_2CH_2-$, -C≡C-, -CH(OH)-, $-CH_2-$, -C(O)-, $-C(O)CH_2-$, $-CH_2C(O)-$, -C(O)CH(OH)-, -CH(OH)C(O)-, $-CH_2N(R^{18})-$, $-N(R^{18})CH_2-$, $-CH_2N(R^{18})CH_2-$, $-CH_2CH_2N(R^{18})-$, $-N(R^{18})CH_2CH_2-$, $-CH_2OCH_2-$, $-CH_2CH_2O-$, $-OCH_2CH_2-$, $-CH_2S(O)_qCH_2-$, $-CH_2CH_2S(O)_q-$, $-S(O)_qCH_2CH_2-$, $-C(O)N(R^{18})-$, $-N(R^{18})C(O)-$, $-N(R^{18})C(O)N(R^{18})-$, $-N(R^{18})C(S)-N(R^{18})-$, $-CH(OH)CH_2-$, $-CH_2CH(OH)-$, -CH=CH-, $-S(O)_qN(R^{18})-$, $-C(O)N(R^{18})C(R^{17})_2$, $-C(O)CH_2CH_2-$, -C(O)C(O)-, -

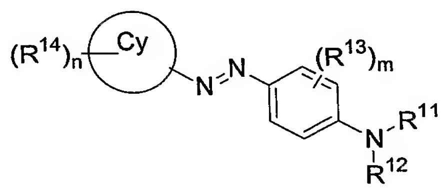
C(C)-, -S(O)-, -, $S(O)_qN(R^{18})C(R^{17})_2$, $-C(O)CH_2C(R^{17})$-, - $CH_2C(O)C(R^{17})$-, - $CHCHS(O)_q$-, NR^{18}-, or $-C(O)C(R^{17})C(R^{17})$- ;q is 0, 1, or 2;

each R^{17} is independently H, alkyl, haloalkyl, hydroxy, or alkoxy; and

each R^{18} is independently H or alkyl.

42. The pesticidal composition of claim 41, wherein Cy is phenyl or pyridyl.

43. A pesticidal composition, comprising an effective amount of a compound of Formula (IIc) or a salt thereof,



Formula (IIc)

wherein,

R^{11} and R^{12} are independently H, hydroxy, oxo, alkyl, haloalkyl, sulfonyl, aminosulfonylalkyl, halosulfonylalkyl, or $-C(O)R^{17}$; or R^{11} and R^{12}, together with the nitrogen to which they are attached, form a heterocycleyl or heteroaryl ring; or one of R^{11} or R^{12}, together with R^{13} and the nitrogen to which is it attached, form a heterocyclyl or heteroaryl ring; each R^{11} and R^{12} can independently be substituted by one or more R^{15};

each R^{13} is independently halo, $C(O)R^{17}$, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, alkyl; each of which is optionally substituted with 1-4 R^{16};

each R^{14} is independently halo, $C(O)R^{17}$, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl, cyclyl, heterocyclyl; each of which is optionally substituted with 1-4 R^{16};

each m and n is independently 0-4;

each R^{15} is independently alkyl, C(O), C(S);

each R^{16} is independently alkyl;

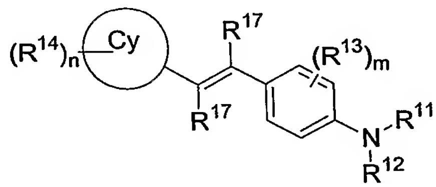
each R^{17} is H, alkyl, haloalkyl, hydroxy, or alkoxy; and

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl.

44. The composition of claim 43, wherein Cy is phenyl or pyridyl.

45. The composition of claim 43 or 44, wherein Cy is phenyl.

46. A pesticidal composition, comprising an effective amount of a compound of Formula (IId) or a salt thereof,



Formula (IId)

wherein,

each R^{11} and R^{12} is independently H, hydroxy, oxo, alkyl, haloalkyl, sulfonyl, aminosulfonylalkyl, halosulfonylalkyl, $C(O)R^{17}$ or R^{11} and R^{12}, together with the nitrogen to which they are attached, form a heterocyclyl or heteroaryl ring; or one of R^{11} or R^{12}, together with R^{13} and the nitrogen to which is it attached, form a heterocycleyl or heteroaryl ring; each R^{11} and R^{12} can independently be substituted by one or more R^{15};

each R^{13} is independently halo, $C(O)R^{17}$, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, alkyl; each of which is optionally substituted with 1-4 R^{16};

each R^{14} is independently halo, $C(O)R^{17}$, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl, cyclyl, heterocyclyl; each of which is optionally substituted with 1-4 R^{16};

each m and n are independently 0-4;

each R^{15} is independently alkyl, C(O), C(S);

each R^{16} is independently alkyl;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl; and

each R^{17} is independently H, alkyl, haloalkyl, hydroxy, or alkoxy.

47. The composition of claim 46, wherein Cy is phenyl or pyridyl.

48. The composition of claim 46 or 47, wherein Cy is phenyl.

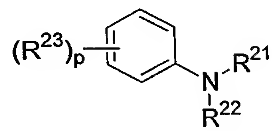
49. The composition of any claims 46-48, wherein R^{11} and R^{12} are H or CF_3.

50. The composition of claim 17, wherein the compound of formula (IIa) is selected from the group consisting of Ethyl-methyl-(4-phenylazo-phenyl)-amine, 2-[4-(4-Dimethylamino-phenylazo)-phenylamino]-ethanesulfonyl fluoride, 2-(4-Phenylazo-phenylamino)-ethanesulfonic acid amide, 2-(4-Phenylazo-phenylamino)-ethanesulfonyl fluoride, Dimethyl-(4-phenylazo-phenyl)-amine, Dimethyl-(3-methyl-4-phenylazo-phenyl)-amine, [4-(4-Bromo-phenylazo)-phenyl]-ethyl-amine, Ethyl-(4-p-tolylazo-phenyl)-amine, Dimethyl-(4-p-tolylazo-phenyl)-amine, 1-(4-Phenylazo-phenyl)-pyrrole-2,5-dione, N-(2-Chloro-4-phenylazo-phenyl)-acetamide, (4-Bromo-phenyl)-(1-methyl-1,2,3,4-tetrahydro-quinolin-6-yl)-diazene, (4-Methoxy-phenyl)-(1-methyl-1,2,3,4-tetrahydro-quinolin-6-yl)-diazene, 5-Dimethylamino-2-(pyridin-2-ylazo)-phenol, Dimethyl-(4-o-tolylazo-phenyl)-amine, Methyl-(4-phenylazo-phenyl)-amine, 4-(4-Nitro-phenylazo)-phenol, [4-(3-Chloro-phenylazo)-phenyl]-dimethyl-amine, Dimethyl-[4-(pyridin-2-ylazo)-phenyl]-amine, [4-(4-methylamino-phenylazo)-phenyl]-dimethyl-amine, 3-[4-(4-Nitro-phenylazo)-phenyl]-2-thioxo-thiazolidin-4-one, (4-Nitro-phenyl)-phenyl-diazene, 3-(4-Dimethylamino-phenyl)-1-phenyl-propenone, (4-Dimethylamino-phenyl)-phenyl-methanone, Bis-(4-methylamino-phenyl)-methanone, [4-(4-Methoxy-phenylazo)-phenyl]-dimethyl-amine, 6-(4-Dimethylamino-phenylazo)-phenylamine, [4-(4-Fluoro-phenylazo)-phenyl]-dimethyl-amine, [4-(4-Bromo-phenylazo)-phenyl]-dimethyl-amine, Dimethyl-[4-(4-nitro-phenylazo)-phenyl]-amine, Methyl-(4-m-tolylazo-phenyl)-amine, Bis-(4-dimethylamino-phenyl)-methanol, Bis-(4-dimethylamino-phenyl)-methane, Dimethyl-(4-styryl-phenyl)-amine, Dimethyl-(4-phenylaminomethyl-phenyl)-amine, 1-(4-Dimethylamino-phenyl)-2-hydroxy-2-phenyl-ethanone, N-(4-Dimethylamino-phenyl)-benzamide, 1-(4-Dimethylamino-phenyl)-2-phenyl-ethanone, 1-(4-Dimethylamino-phenyl)-2-phenyl-ethanol, 1-(4-Dimethylamino-phenyl)-3-phenyl-thiourea, 1-(4-Dimethylamino-phenyl)-3-phenyl-urea, and [4-(Benzylamino-methyl)-phenyl]-dimethyl-amine.

51. A method for control of unwanted nematodes or apicomplexan parasites, the method comprising administering to vertebrates, plants, seeds or soil a pesticidal

composition of claim any of claims 1-50.

52. A pesticidal composition, comprising an effective amount of a compound of Formula (III) or a salt thereof,



Formula (III)

wherein,

each R^{21} and R^{22} is independently H, alkyl, haloalkyl, $C(O)R^{26}$, $S(O)_2R^{27}$, PO_3H_2, aryl, or arylalkyl; each of which is optionally substituted with 1-4 R^{24}; or R^{21} and R^{22}, together with the nitrogen to which they are attached, form a heterocyclyl, which is optionally substituted with 1-4 R^{24};

each R^{23} is independently nitro, nitroso, amino, halo, alkyl, haloalkyl, hydroxy, alkoxy, $NR^{28}C(O)R^{26}$, $C(O)R^{26}NR^{28}R^{29}$, aryl, heteroaryl, or heterocyclyl, each of which is optionally substituted with 1-4 R^{25};

each R^{24} is independently halo, alkyl, haloalkyl,

each R^{25} is independently halo, alkyl, haloalkyl, hydroxy, alkoxy, nitro, cyano;

R^{26} is hydroxy, alkyl, or alkoxy;

R^{27} is alkyl, haloalkyl, hydroxy or alkoxy;

each R^{28} and R^{29} is independently H or alkyl; and

p is 0-4.

53. The composition of claim 52, wherein each R^{21} and R^{22} is independently H or alkyl.

54. The composition of claim 52 or 53, wherein R^{21} is H and R^{22} is alkyl;

55. The composition of claim 52 or 53, wherein R^{21} is H and R^{22} is ethyl.

56. The composition of claim 52 or 53, wherein R^{22} is methyl or ethyl.

57. The composition of any of claim 52-56, wherein p is 1 or 2.

58. The composition of any of claims 52-57, wherein each R^{23} is independently halo, alkyl, hydroxy, alkoxy, nitro, nitroso, or amino.

59. The composition of any of claims 52-58, wherein
each R^{21} and R^{22} is H, or alkyl;
each R^{23} is independently halo, alkyl, hydroxy, alkoxy, nitro, nitroso, or amino; and
p is 0-2.

60. The composition of claim 59, wherein each R^{21} and R^{22} is H, methyl, or ethyl.

61. The pesticidal composition of any of claims 52-60, wherein the compound of Formula (III) has a molecular weight of less than 500 Daltons.

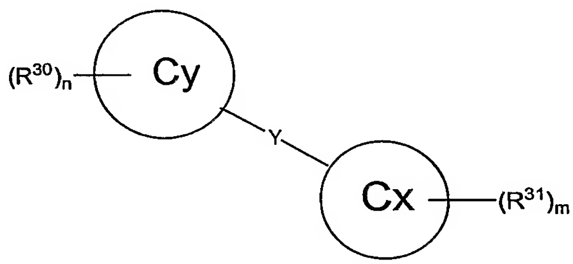
62. The pesticidal composition of any of claims 52-61, wherein the compound of Formula (III) comprises at least one I or Br.

63. The pesticidal composition of claim 52, wherein the compound of Formula (III) is selected from the group consisting of 2-Phenylamino-ethanesulfonyl fluoride, N-ethylaniline, Methyl-phenyl-amine, Dimethyl-phenyl-amine, N,N,N',N'-Tetramethyl-benzene-1,4-diamine, Methyl-(4-nitro-phenyl)-amine, Ethyl-(4-nitro-phenyl)-amine, Methyl-(2-nitro-phenyl)-amine, Dimethyl-(4-nitro-phenyl)-amine, (2-Chloro-4-nitro-phenyl)-dimethyl-amine, (2-Chloro-phenyl)-dimethyl-amine, Ethyl-(2-methyl-5-nitro-phenyl)-amine, N1-Methyl-4-nitro-benzene-1,2-diamine, N1-Ethyl-4-nitro-benzene-1,2-diamine, (2,4-Dinitro-phenyl)-methyl-amine, (2,4-Dinitro-phenyl)-ethyl-amine, Methyl-(4-nitroso-phenyl)-amine, N,N-Dimethyl-benzene-1,4-diamine, (4-Methoxy-phenyl)-methyl-amine, N-Methyl-benzene-1,2-diamine, (2-Bromo-4-methyl-phenyl)-ethyl-amine, Methyl-o-tolyl-amine, Dimethyl-o-tolyl-amine, Dimethyl-m-tolyl-amine, Dimethyl-p-tolyl-amine, Ethyl-o-tolyl-amine, Ethyl-m-tolyl-amine, (2-Chloro-phenyl)-methyl-amine, (4-Chloro-phenyl)-methyl-amine, (4-Chloro-phenyl)-

ethyl-amine, 3-Dimethylamino-phenol, 3-Ethylamino-4-methyl-phenol, 4-Methylamino-phenol, [4-(2,3-Dihydro-benzothiazol-2-yl)-phenyl]-dimethyl-amine, [4-(2,3-Dihydro-benzooxazol-2-yl)-phenyl]-dimethyl-amine, and [4-(1,3-Dimethyl-2,3-dihydro-1H-benzoimidazol-2-yl)-phenyl]-dimethyl-amine.

64. A method for control of unwanted nematodes or apicomplexan parasites, the method comprising administering to vertebrates, plants, seeds or soil a pesticidal composition of any of claims 51-63.

65. A pesticidal composition, comprising an effective amount of a compound of Formula (IVa) or a salt thereof.



Formula (IVa)

wherein,

each R^{30} is independently $C(O)R^{33}$, halo, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl or cyclyl; each of which is optionally substituted with 1-4 R^{32};

each R^{31} is independently $C(O)R^{33}$, halo, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl or cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{32};

m and n are independently 0-4;

each R^{32} is independently halogen, -OH, alkyl, or $C(O)R^{33}$;

Cx is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Y is -N=N-, $-C(R^{17})=C(R^{17})-$, $-C(O)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(O)-$, $-C(OH)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(OH)-$, $-CH_2CH_2-$, -C≡C-, -CH(OH)-, $-CH_2-$, -

C(O)-, -C(O)CH$_2$-, -CH$_2$C(O)-, -C(O)CH(OH)-, -CH(OH)C(O)-, -CH$_2$N(R^{18})-, -N(R^{18})CH$_2$-, -CH$_2$N(R^{18})CH$_2$-, -CH$_2$CH$_2$N(R^{18})-, -N(R^{18})CH$_2$CH$_2$-, -CH$_2$OCH$_2$-, -CH$_2$CH$_2$O-, -OCH$_2$CH$_2$-, -CH$_2$S(O)$_q$CH$_2$-, -CH$_2$CH$_2$S(O)$_q$-, -S(O)$_q$CH$_2$CH$_2$-, -C(O)N(R^{18})-, -N(R^{18})C(O)-, -N(R^{18})C(O)N(R^{18})-, -N(R^{18})C(S)-N(R^{18})-, -CH(OH)CH$_2$-, -CH$_2$CH(OH)-, -CH=CH-, -S(O)$_q$N(R^{18})-, -C(O)N(R^{18})C(R^{17})$_2$, -C(O)CH$_2$CH$_2$-, -C(O)C(O)-, -C(C)-, -S(O)-, -, S(O)$_q$N(R^{18})C(R^{17})$_2$, -C(O)CH$_2$C(R^{17})-, -CH$_2$C(O)C(R^{17})-, -CHCHS(O)$_q$-, NR^{18}-, or –C(O)C(R^{17})C(R^{17})- ;

q is 0, 1, or 2;

each R^{33} is independently H, alkyl, haloalkyl, hydroxy, or alkoxy; and

each R^{34} is independently H or alkyl, provided that when Cy and Cx are benzyl and Y is -C(O)CH=CH-, m and n are not both 0.

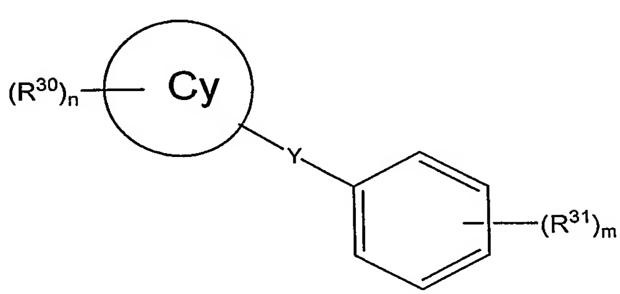
66. The pesticidal composition of claim 65 wherein Cx or Cy is pyridyl.

67. The pesticidal composition of claim 65 or 66 wherein Cx or Cy is phenyl.

68. The pesticidal composition of any of claim 65-67 wherein Cx is phenyl, n is 1, and C^{30} is positioned para to Y.

69. The pesticidal composition of any of claims 65-68 wherein R^{31} is H, alkyl, hydroxy, halo, and Y is -N=N-, -CR^{33}=CR^{33}-, -C(O)CR^{33}=CR^{33}-, -CR^{33}=CR^{33}C(O)-, -C(OH)CR^{33}=CR^{33}-, -CR^{33}=CR^{33}C(OH)-, -CH(OH)-, or -C(O)-.

70. A pesticidal composition, comprising an effective amount of a compound of Formula (IVb) or a salt thereof.



Formula (IVb)

wherein

each R^{30} is independently $C(O)R^{33}$, halo, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl, cyclyl; each of which is optionally substituted with 1-4 R^{32};

each R^{31} is independently $C(O)R^{33}$, halo, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl, cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{32};

each m and n is independently 0-4;

each R^{32} is independently halogen, -OH, alkyl, or $C(O)R^{33}$;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

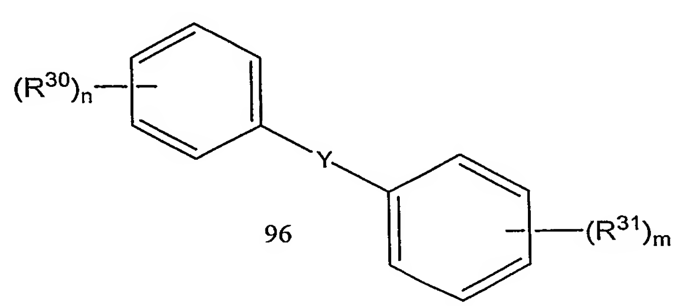
Y is -N=N-, $-C(R^{17})=C(R^{17})-$, $-C(O)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(O)-$, $-C(OH)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(OH)-$, $-CH_2CH_2-$, -C≡C-, -CH(OH)-, $-CH_2-$, -C(O)-, $-C(O)CH_2-$, $-CH_2C(O)-$, -C(O)CH(OH)-, -CH(OH)C(O)-, $-CH_2N(R^{18})-$, $-N(R^{18})CH_2-$, $-CH_2N(R^{18})CH_2-$, $-CH_2CH_2N(R^{18})-$, $-N(R^{18})CH_2CH_2-$, $-CH_2OCH_2-$, $-CH_2CH_2O-$, $-OCH_2CH_2-$, $-CH_2S(O)_qCH_2-$, $-CH_2CH_2S(O)_q-$, $-S(O)_qCH_2CH_2-$, $-C(O)N(R^{18})-$, $-N(R^{18})C(O)-$, $-N(R^{18})C(O)N(R^{18})-$, $-N(R^{18})C(S)-N(R^{18})-$, $-CH(OH)CH_2-$, $-CH_2CH(OH)-$, -CH=CH-, $-S(O)_qN(R^{18})-$, $-C(O)N(R^{18})C(R^{17})_2$, $-C(O)CH_2CH_2-$, -C(O)C(O)-, -C(C)-, -S(O)-, -, $S(O)_qN(R^{18})C(R^{17})_2$, $-C(O)CH_2C(R^{17})-$, $-CH_2C(O)C(R^{17})-$, $-CHCHS(O)_q-$, $NR^{18}-$, or $–C(O)C(R^{17})C(R^{17})-$;

q is 0, 1, or 2;

each R^{33} is independently H, alkyl, haloalkyl, hydroxy, or alkoxy; and

each R^{34} is independently H or alkyl, provided that when Cy is benzyl and Y is -C(O)CH=CH-, m and n are not both 0.

71. A pesticidal composition, comprising an effective amount of a compound of Formula (IVc) or a salt thereof



Formula (IVc)

wherein:

each R^{30} is independently $C(O)R^{33}$, halo, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl, cyclyl; each of which is optionally independently substituted with 1-4 R^{32};

each R^{31} is independently $C(O)R^{33}$, halo, haloalkyl, aminohaloalkyl, sulfonyl, hydroxy, alkoxy, amino, alkyl, nitro, aryl, heteroaryl, cyclyl, or heterocyclyl; each of which is optionally independently substituted with 1-4 R^{32};

each m and n is independently 0-4;

each R^{32} is independently halogen, -OH, alkyl, or $C(O)R^{33}$;

Cy is phenyl, pyridyl, pyrimidyl, furanyl, pyranyl, thienyl, isothiazolyl, pyrrolyl, imidazolyl, pyrazinyl, isooxazolyl or pyrazolyl;

Y is -N=N-, $-C(R^{17})=C(R^{17})-$, $-C(O)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(O)-$, $-C(OH)C(R^{17})=C(R^{17})-$, $-C(R^{17})=C(R^{17})C(OH)-$, $-CH_2CH_2-$, -C≡C-, -CH(OH)-, $-CH_2-$, -C(O)-, $-C(O)CH_2-$, $-CH_2C(O)-$, -C(O)CH(OH)-, -CH(OH)C(O)-, $-CH_2N(R^{18})-$, $-N(R^{18})CH_2-$, $-CH_2N(R^{18})CH_2-$, $-CH_2CH_2N(R^{18})-$, $-N(R^{18})CH_2CH_2-$, $-CH_2OCH_2-$, $-CH_2CH_2O-$, $-OCH_2CH_2-$, $-CH_2S(O)_qCH_2-$, $-CH_2CH_2S(O)_q-$, $-S(O)_qCH_2CH_2-$, $-C(O)N(R^{18})-$, $-N(R^{18})C(O)-$, $-N(R^{18})C(O)N(R^{18})-$, $-N(R^{18})C(S)-N(R^{18})-$, $-CH(OH)CH_2-$, $-CH_2CH(OH)-$, -CH=CH-, $-S(O)_qN(R^{18})-$, $-C(O)N(R^{18})C(R^{17})_2$, $-C(O)CH_2CH_2-$, -C(O)C(O)-, -C(C)-, -S(O)-, -, $S(O)_qN(R^{18})C(R^{17})_2$, $-C(O)CH_2C(R^{17})-$, $-CH_2C(O)C(R^{17})-$, $-CHCHS(O)_q-$, $NR^{18}-$, or $–C(O)C(R^{17})C(R^{17})-$;

q is 0, 1, or 2;

each R^{33} is independently H, alkyl, haloalkyl, hydroxy, or alkoxy; and

each R^{34} is independently H or alkyl, provided that when Y is -C(O)CH=CH-, m and n are not both 0.

72. The pesticidal composition of claim 71 wherein Y is -N=N-.

73. The pesticidal composition of claim 71 wherein Y is $-CR^{33}=CR^{33}-$.

74. The pesticidal composition of claim 71 wherein Y is -C(O)CR^{33}=CR^{33}- or -CR^{33}=CR^{33}C(O)-.

75. The pesticidal composition of any of claims 71-74 wherein n is 0, 1 or 2 and m is 0, 1, or 2.

76. The pesticidal composition of any of claims 71-75 wherein each R^{30} and each R^{31} is independently: H, -OH, -CH_3, -CF_3, -CCl_3, F, Cl, Br, -$N(CH_3)_2$, -$NH(CH_3)$, -$NHCH_2CH_3$, -C(O)H, -COOH, -SO_3H, -$COCF_3$, -$N(CF_3)_2$, -SO_2CF_3, -SO_2CH_3, -SO_2CHF_2, -SO_2CN, -$SO_2N(CH_3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$.

77. The pesticidal composition of any of claims 71-76 wherein each R^{30} and each R^{31} is independently selected from: COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

78. The pesticidal composition of any of claims 71-76 wherein each R^{30} is independently selected from: a halogen, COOH, SO_3H, CF_2H, CFH_2, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

79. The pesticidal composition of any of claims 71-75 wherein each R^{31} is independently selected from: COOH, SO_3H, CF_2H, CFH_2, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

80. The pesticidal composition of any of claims 71-79 wherein n is 1 or 2 and m is 1 or 2.

81. The pesticidal composition of any of claims 71-80 wherein each R^{30} is independently selected from: CF_3, CF_2H, CFH_2, SO_2CH_3, SO_2NHCH_3, SO_2CF_3 and OH.

82. The pesticidal composition of any of claims 71-81 wherein Y is selected from –N=N-, -C(O)CH=CH- and -CH=CH-, provided that when Y is -C(O)CH=CH-, m and n are not both 0.

83. A method for control of unwanted nematodes or apicomplexan parasites, the method comprising administering to vertebrates, plants, seeds or soil a pesticidal composition of claim any of claims 71-82.

84. The pesticidal composition of claim 65 comprising a compound selected from the group consisting of:

(E)-2-(4-(phenyldiazenyl)phenylamino)ethanesulfonyl fluoride;
(E)-N-ethyl-N-methyl-4-(phenyldiazenyl)aniline;
(E)-N-methyl-4-(phenyldiazenyl)aniline;
(E)-1,2-diphenyldiazene;
(E)-4-((4-bromophenyl)diazenyl)-N-ethylaniline;
(E)-N-ethyl-4-(p-tolyldiazenyl)aniline;
(E)-1-phenyl-2-p-tolyldiazene;
(E)-N-methyl-4-(m-tolyldiazenyl)aniline;
(E)-N,N,3-trimethyl-4-(phenyldiazenyl)aniline;
(E)-N,N-dimethyl-4-(phenyldiazenyl)aniline;
(E)-1-(4-chlorophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;
(E)-1-phenyl-2-(3-(trifluoromethyl)phenyl)diazene;
(E)-1-phenyl-2-(2-(trifluoromethyl)phenyl)diazene;
(E)-2-(phenyldiazenyl)phenol;
(E)-1-(4-bromophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;
(Z)-2-(phenyldiazenyl)phenol;
(E)-1-phenyl-2-(4-(trifluoromethyl)phenyl)diazene;
(E)-2-(phenyldiazenyl)-5-(trifluoromethyl)phenol;
(E)-2-((4-(trifluoromethyl)phenyl)diazenyl)phenol;
(E)-2-((3-(trifluoromethyl)phenyl)diazenyl)phenol;
(E)-1-(3-chlorophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;
(E)-2-((3-chlorophenyl)diazenyl)-5-(trifluoromethyl)phenol;
(E)-1-(3-bromophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;

N-methyl-4-nitroaniline;
(E)-chalcone;
(E)-4-styrylbenzaldehyde;
(E)-1,2-diphenylethene;
(E)-2-styrylphenol; and
(E)-3-styrylphenol.

85. A pesticidal composition comprising a compound selected from the group consisting of:

3-(4-(dimethylamino)phenyl)-1-(2-nitrophenyl)propan-1-one;
Benzyl;
N-benzylaniline;
1,3-diphenylprop-2-yn-1-one;
2,5-diphenylfuran;
2-phenylbenzo[d]oxazole;
Diphenylamine; and
(E)-3-(4-chlorophenyl)-2-methyl-1-phenylbut-2-en-1-one.

86. The composition of claim 76 wherein the compound is selected from the group consisting of:

(E)-1-(4-chlorophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;
(E)-1-phenyl-2-(3-(trifluoromethyl)phenyl)diazene;
(E)-1-phenyl-2-(2-(trifluoromethyl)phenyl)diazene;
(E)-2-(phenyldiazenyl)phenol;
(E)-1-(4-bromophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;
(Z)-2-(phenyldiazenyl)phenol;
(E)-1-phenyl-2-(4-(trifluoromethyl)phenyl)diazene;
(E)-2-(phenyldiazenyl)-5-(trifluoromethyl)phenol;
(E)-2-((4-(trifluoromethyl)phenyl)diazenyl)phenol;
(E)-2-((4-(trifluoromethyl)phenyl)diazenyl)phenol;
(E)-2-((3-bromophenyl)diazenyl)-5-(trifluoromethyl)phenol;
(E)-2-((4-chlorophenyl)diazenyl)-5-(trifluoromethyl)phenol
(E)-2-((3-(trifluoromethyl)phenyl)diazenyl)phenol;

(E)-1-(3-chlorophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;

(E)-2-((3-chlorophenyl)diazenyl)-5-(trifluoromethyl)phenol;

(E)-1-(3-bromophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;

87. The composition of claim 76 wherein the compound is selected from the group consisting of:

(E)-1-(4-chlorophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;

(E)-1-phenyl-2-(3-(trifluoromethyl)phenyl)diazene;

(E)-1-phenyl-2-(2-(trifluoromethyl)phenyl)diazene;

(E)-2-(phenyldiazenyl)phenol;

(E)-1-(4-bromophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;

(Z)-2-(phenyldiazenyl)phenol;

(E)-1-phenyl-2-(4-(trifluoromethyl)phenyl)diazene;

(E)-2-(phenyldiazenyl)-5-(trifluoromethyl)phenol;

(E)-2-((4-(trifluoromethyl)phenyl)diazenyl)phenol;

(E)-2-((4-(trifluoromethyl)phenyl)diazenyl)phenol;

(E)-2-((3-bromophenyl)diazenyl)-5-(trifluoromethyl)phenol;

(E)-2-((4-chlorophenyl)diazenyl)-5-(trifluoromethyl)phenol

(E)-2-((3-(trifluoromethyl)phenyl)diazenyl)phenol;

(E)-1-(3-chlorophenyl)-2-(4-(trifluoromethyl)phenyl)diazene;

(E)-2-((3-chlorophenyl)diazenyl)-5-(trifluoromethyl)phenol; and

(E)-1-(3-bromophenyl)-2-(4-(trifluoromethyl)phenyl)diazene.

88. The pesticidal composition of any of claims 65 – 69, wherein each R^{30} is independently $C(O)R^{33}$, halo, haloalkyl, sulfonyl, hydroxy, alkoxy, alkyl, aryl, heteroaryl or cyclyl; each of which is optionally substituted with 1-4 R^{32} and each R^{31} is independently $C(O)R^{33}$, halo, haloalkyl, sulfonyl, hydroxy, alkoxy, alkyl, aryl, heteroaryl or cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{32}.

89. The pesticidal composition of claim 70, wherein each R^{30} is independently $C(O)R^{33}$, halo, haloalkyl, sulfonyl, hydroxy, alkoxy, alkyl, aryl, heteroaryl or cyclyl; each of which is optionally substituted with 1-4 R^{32} and each R^{31}

is independently $C(O)R^{33}$, halo, haloalkyl, sulfonyl, hydroxy, alkoxy, alkyl, aryl, heteroaryl or cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{32}.

90. The pesticidal composition of claim 65, wherein each R^{30} is independently $C(O)R^{33}$, halo, haloalkyl, sulfonyl, hydroxy, alkoxy, alkyl, aryl, heteroaryl or cyclyl; each of which is optionally substituted with 1-4 R^{32} and each R^{31} is independently $C(O)R^{33}$, halo, haloalkyl, sulfonyl, hydroxy, alkoxy, alkyl, aryl, heteroaryl or cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{32}.

91. The pesticidal composition of claim 65 or 90 wherein Y is -N=N-.

92. The pesticidal composition of claim 65 or 90 wherein Y is $-CR^{33}=CR^{33}-$.

93. The pesticidal composition of claim 65 or 90 wherein Y is $-C(O)CR^{33}=CR^{33}-$ or $-CR^{33}=CR^{33}C(O)-$.

94. The pesticidal composition of any of claims 65 and 90-93 wherein n is 0, 1 or 2 and m is 0, 1, or 2.

95. The pesticidal composition of any of claims 65 and 90-94 wherein each R^{30} and each R^{31} is independently: H, -OH, $-CH_3$, $-CF_3$, $-CCl_3$, F, Cl, Br, $-N(CH_3)_2$, $-NH(CH_3)$, $-NHCH_2CH_3$, -C(O)H, -COOH, $-SO_3H$, $-COCF_3$, $-N(CF_3)_2$, $-SO_2CF_3$, $-SO_2CH_3$, $-SO_2CHF_2$, $-SO_2CN$, $-SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$,.

96. The pesticidal composition of any of claims 65 and 90-94 wherein each R^{30} and each R^{31} is independently selected from: COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

97. The pesticidal composition of any of claims 65 and 90-94 and wherein each R^{30} is independently selected from: a halogen, COOH, SO_3H, CF_2H, CFH_2, CF_3,

$COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

98. The pesticidal composition of any of claims 65 and 90-94 wherein each R^{31} is independently selected from: COOH, SO_3H, CF_2H, CFH_2, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

99. The pesticidal composition of any of claims 65 and 90-98 wherein n is 1 or 2 and m is 1 or 2.

100. The pesiticidal composition of any of claims 65 and 90-99 wherein each R^{30} is independently selected from: CF_3, CF_2H, CFH_2, SO_2CH_3, SO_2NHCH_3, SO_2CF_3 and OH.

101. The pesticidal composition of any of claims 65 and 90-100 wherein Y is selected from –N=N-, -C(O)CH=CH- and -CH=CH-.

102. The pesticidal composition of claim 70, wherein each R^{30} is independently $C(O)R^{33}$, halo, haloalkyl, sulfonyl, hydroxy, alkoxy, alkyl, aryl, heteroaryl or cyclyl; each of which is optionally substituted with 1-4 R^{32} and each R^{31} is independently $C(O)R^{33}$, halo, haloalkyl, sulfonyl, hydroxy, alkoxy, alkyl, aryl, heteroaryl or cyclyl, or heterocyclyl; each of which is optionally substituted with 1-4 R^{32}.

103. The pesticidal composition of claim 70 or 102 wherein Y is -N=N-.

104. The pesticidal composition of claim 70 or 102 wherein Y is -CR^{33}=CR^{33}-.

105. The pesticidal composition of claim 70 or 102 wherein Y is -$C(O)CR^{33}$=CR^{33}- or -CR^{33}=$CR^{33}C(O)$-.

106. The pesticidal composition of any of claims 70 and 102-105 wherein n is 0, 1 or 2 and m is 0, 1, or 2.

107. The pesticidal composition of any of claims 70 and 102-105 wherein each R^{30} and each R^{31} is independently: H, -OH, $-CH_3$, $-CF_3$, $-CCl_3$, F, Cl, Br, -$N(CH_3)_2$, $-NH(CH_3)$, $-NHCH_2CH_3$, -C(O)H, -COOH, $-SO_3H$, $-COCF_3$, $-N(CF_3)_2$, -SO_2CF_3, $-SO_2CH_3$, $-SO_2CHF_2$, $-SO_2CN$, $-SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, $SO_2C_6H_5$,.

108. The pesticidal composition of any of claims 70 and 102-105 wherein each R^{30} and each R^{31} is independently selected from: COOH, SO_3H, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

109. The pesticidal composition of any of claims 70 and 102-105 wherein each R^{30} is independently selected from: a halogen, COOH, SO_3H, CF_2H, CFH_2, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

110. The pesticidal composition of any of claims 70 and 102-105 wherein each R^{31} is independently selected from: COOH, SO_3H, CF_2H, CFH_2, CF_3, $COCF_3$, CCl_3, CBr_3, CI_3, $N(CF_3)_2$, SO_2CF_3, SO_2CH_3, SO_2CHF_2, SO_2CN, $SO_2N(CH_3)_2$, SO_2NHCH_3, SO_2NH_2, and $SO_2C_6H_5$.

111. The pesticidal composition of any of claims 70 and 102-110 wherein n is 1 or 2 and m is 1 or 2.

112. The pesticidal composition of any of claims 70 and 102-111 wherein each R^{30} is independently selected from: CF_3, CF_2H, CFH_2, SO_2CH_3, SO_2NHCH_3, SO_2CF_3 and OH.

113. The pesticidal composition of any of claims 70 and 102-112 wherein Y is selected from –N=N-, -C(O)CH=CH- and -CH=CH-.

114. A method for control of unwanted nematodes or apicomplexan parasites, the method comprising administering to vertebrates, plants, seeds or soil a pesticidal composition of any of claims 1-15, 17-27, 29-50, 52-63, 65-82 and 84-113.

115. A method for control of unwanted nematodes, the method comprising administering to vertebrates, plants, seeds or soil a pesticidal composition of any of claims 1-15, 17-27, 29-50, 52-63, 65-82 and 84-113.

116. A method for control of unwanted apicomplexan parasites, the method comprising administering to vertebrates, plants, seeds or soil a pesticidal composition of any of claims 1-15, 17-27, 29-50, 52-63, 65-82 and 84-113.

117. A method for control of unwanted nematodes, the method comprising administering to plants, seeds or soil a pesticidal composition of any of claims 1-15, 17-27, 29-50, 52-63, 65-82 and 84-113.

118. A method for control of unwanted apicomplexan parasites, the method comprising administering to vertebrates, plants, seeds or soil a pesticidal composition of any of claims 1-15, 17-27, 29-50, 52-63, 65-82 and 84-113.

119. A method for control of unwanted nematodes, the method comprising administering to vertebrates a pesticidal composition of any of claims 1-15, 17-27, 29-50, 52-63, 65-82 and 84-113.

120. A method for control of unwanted apicomplexan parasites, the method comprising administering to plants, seeds or soil a pesticidal composition of any of claims 1-15, 17-27, 29-50, 52-63, 65-82 and 84-113.

121. The method of claim 117 wherein the nematodes are selected from the group consisting of: *Anguina, Ditylenchus, Tylenchorhynchus, Pratylenchus, Radopholus, Hirschmanniella, Nacobbus, Hoplolaimus, Scutellonema, Rotylenchus,*

Helicotylenchus, Rotylenchulus, Belonolaimus, Heterodera, other cyst nematodes, Meloidogyne, Criconemoides, Hemicycliophora, Paratylenchus, Tylenchulus, Aphelenchoides, Bursaphelenchus, Rhadinaphelenchus, Longidorus, Xiphinema, Trichodorus, and *Paratrichodorus, Dirofiliaria, Onchocerca, Brugia, Acanthocheilonema, Aelurostrongylus, Anchlostoma, Angiostrongylus, Ascaris, Bunostomum, Capillaria, Chabertia, Cooperia, Crenosoma, Dictyocaulus, Dioctophyme, Dipetalonema, Dracunculus, Enterobius, Filaroides, Haemonchus, Lagochilascaris, Loa, Manseonella, Muellerius, Necator, Nematodirus, Oesophagostomum,Ostertagia, Parafilaria, Parascaris, Physaloptera, Protostrongylus, Setaria, Spirocerca, Stephanogilaria, Strongyloides, Strongylus, Thelazia, Toxascaris, Toxocara, Trichinella, Trichostrongylus, Trichuris, Uncinaria,* and *Wuchereria.*

122. The method of claim 121 wherein the nematodes are selected from the group consisting of: *Dirofilaria, Onchocerca, Brugia, Acanthocheilonema, Dipetalonema, Loa, Mansonella, Parafilaria, Setaria, Stephanofilaria,* and *Wucheria, Pratylenchus, Heterodera, Meloidogyne, Paratylenchus.*

123. The method of claim 121 wherein the nematodes are selected from the group consisting of: *Ancylostoma caninum, Haemonchus contortus, Trichinella spiralis, Trichurs muris, Dirofilaria immitis, Dirofilaria tenuis, Dirofilaria repens, Dirofilari ursi, Ascaris suum, Toxocara canis, Toxocara cati, Strongyloides ratti, Parastrongyloides trichosuri, Heterodera glycines, Globodera pallida, Meloidogyne javanica, Meloidogyne incognita,* and *Meloidogyne arenaria, Radopholus similis, Longidorus elongatus, Meloidogyne hapla*, and *Pratylenchus penetrans.*

124. The method of claim 121 wherein the nematodes are selected from the group consisting of: *Heterodera glycines, Meloidogyne javanica,* and *Meloidogyne incognita.*

125. The method of claim 118 wherein the plants or seed are soybean.

126. The method of claim 118 wherein the plants or seed are tomato.

127. The method of claim 118 wherein the plants or seed are turf grass.

128. The method of claim 118 wherein the plants or seeds are sugar beet.

129. The method of claim 118 wherein the plants or seeds are wheat.

130. The method of claim 118 wherein the plants or seeds are alfalfa.

131. The method of claim 118 wherein the plants or seeds are corn.

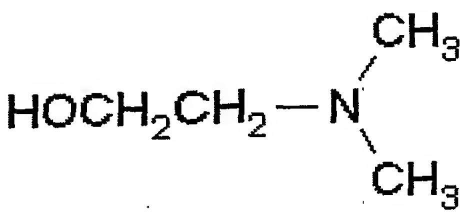
132. The method of claim 118 wherein the plants or seeds are cotton.

$HOCH_2CH_2NH_2$

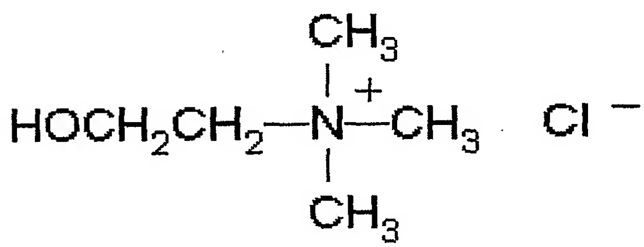
Ethanolamine

$CH_3NHCH_2CH_2OH$

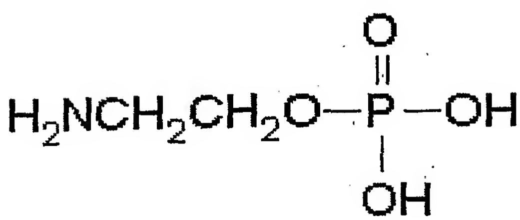
Monomethylethanolamine



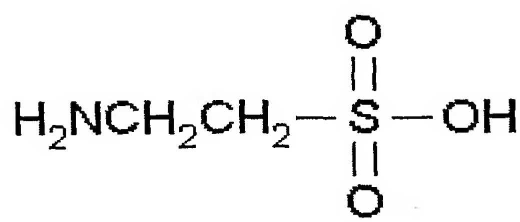
Dimethylethanolamine



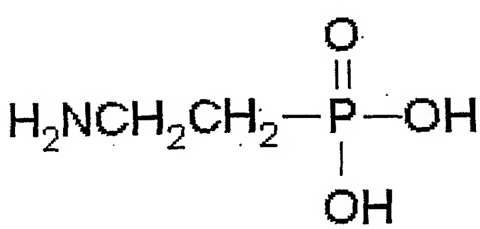
Choline chloride



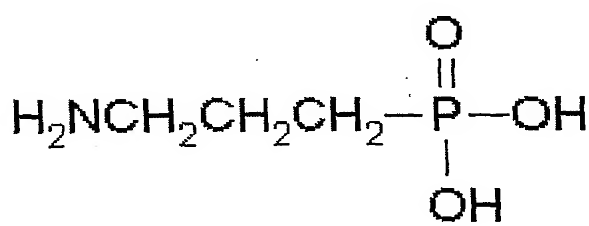
Phosphoethanolamine



Taurine

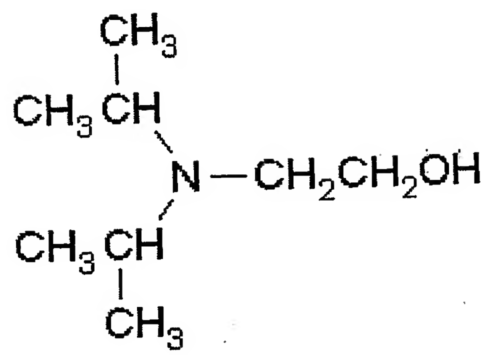


2-Aminoethylphosphonic acid

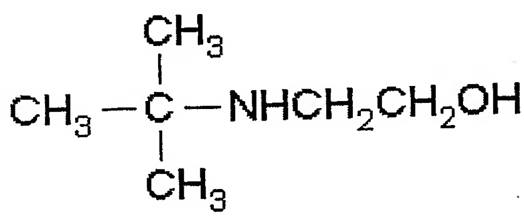


3-Aminopropylphosphonic acid

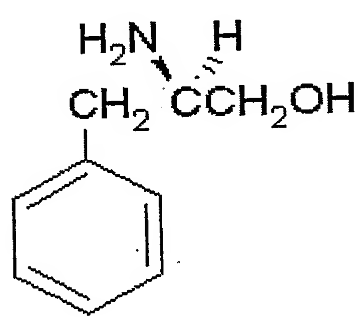
Figure 1



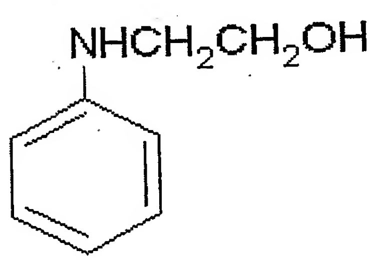
2-(Diisopropylamino)ethanol



2-(tert-Butylamino)ethanol



D-Phenylalaninol

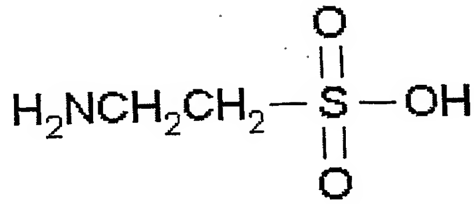


N-(2-Hydroxyethyl)aniline

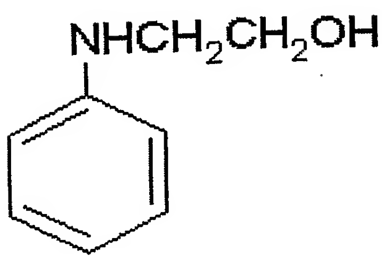
Figure 2

$HOCH_2CH_2NH_2$

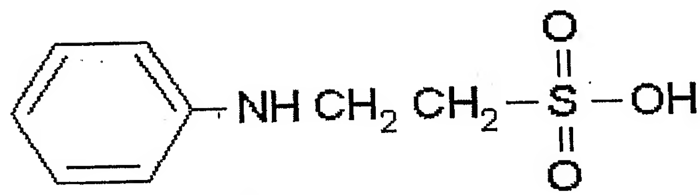
Ethanolamine



Taurine

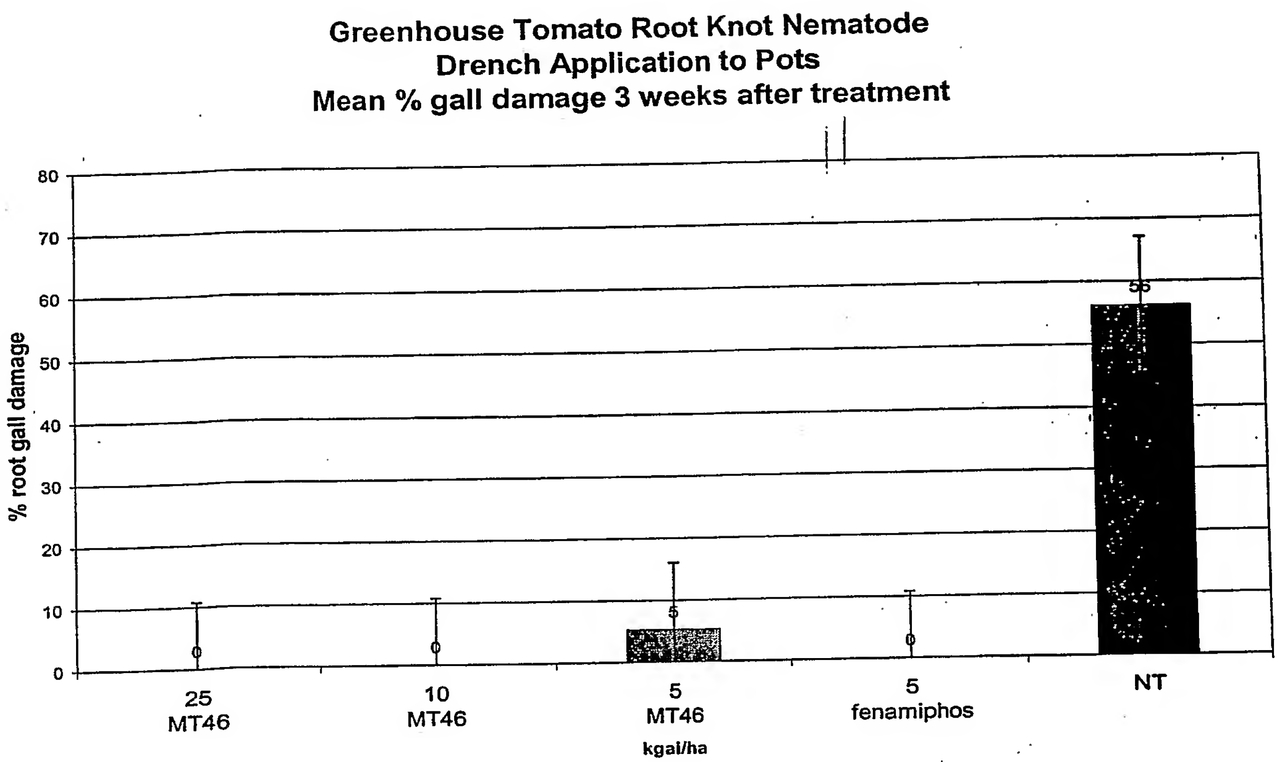


N-(2-Hydroxyethyl)aniline



N-Phenyltaurine

Figure 3


Greenhouse Tomato Root Knot Nematode
Drench Application to Pots
Mean % gall damage 3 weeks after treatment
% root gall damage
0
10
20
30
40
50
60
70
80
0
0
5
0
25
MT46
10
MT46
5
MT46
5
fenamiphos
NT
kgai/ha

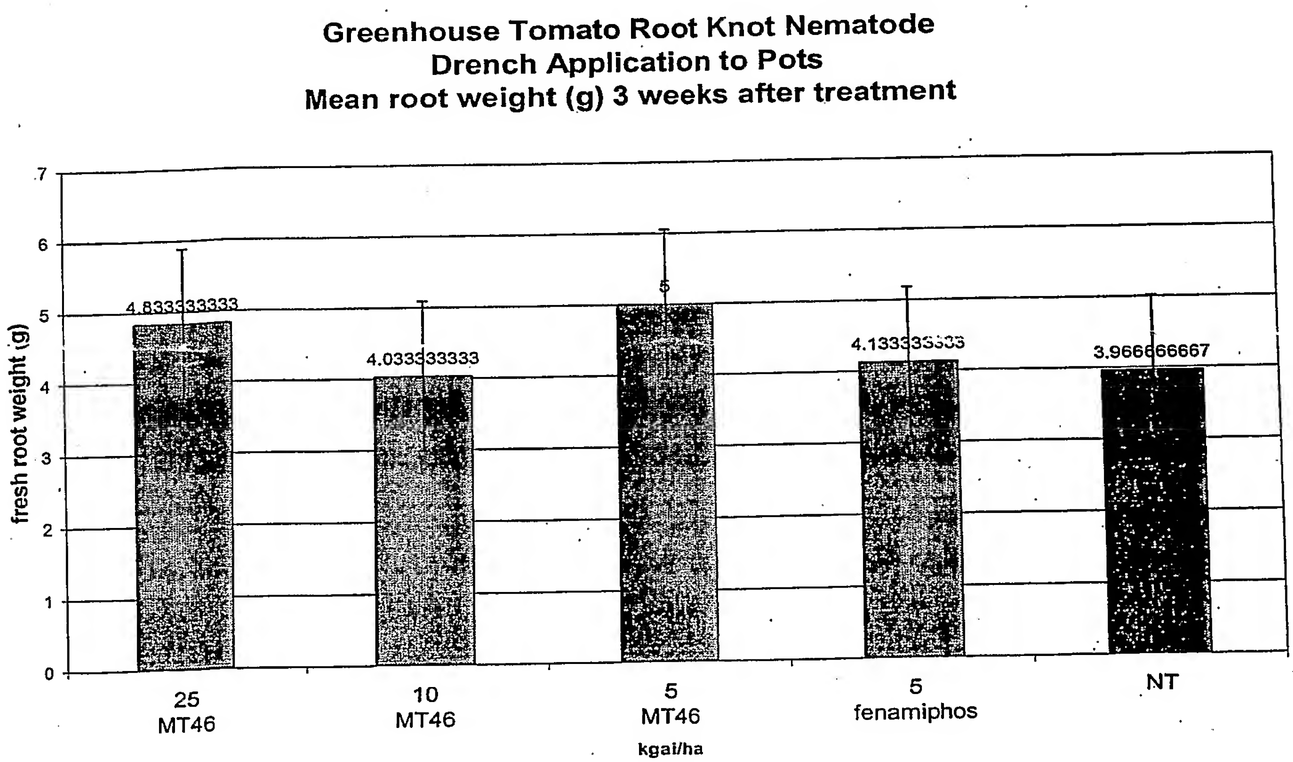

Greenhouse Tomato Root Knot Nematode
Drench Application to Pots
Mean root weight (g) 3 weeks after treatment
fresh root weight (g)
0
1
2
3
4
5
6
7
4.833333333
4.033333333
5
4.133333333
3.966666667
25
MT46
10
MT46
5
MT46
5
fenamiphos
NT
kgai/ha

Figure 4

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11/244,734 6 October 2005 (06.10.2005) US

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(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **HRESKO, Michelle, Coutu** [US/US]; 1349 Stillhouse Creek Road, Chesterfield, Missouri 63017 (US). **WILLIAMS, Deryck, J.** [GY/US]; 751 Yale Avenue, University City, Missouri 63130 (US). **MCLAIRD, Merry, B.** [US/US]; 1205 North Clay Avenue, Kirkwood, Missouri 63122 (US). **BRADLEY, John, D.** [US/US]; 11426 Daykin Drive, St. Louis, Missouri 63146 (US). **SHORTT, Barry, J.** [US/US]; 78 St. Charles Street, New Melle, Missouri 63365 (US). **WORTHINGTON, Ronald, E.** [US/US]; 224 Gray Avenue, St. Louis, Missouri 63119 (US). **LU, Qian** [US/US]; 310 Shady Meadows Drive, Ballwin, Missouri 63011 (US). **DUMAS, Daniel** [FR/GB]; Holmleigh, Hobbacott Lane, Marhamchurch, Bude Cornwall EX23 OHD (GB).

(74) Agents: **MEIKLEJOHN, Anita, L.** et al.; Fish & Richardson P.C., P.o. Box 1022, Minneapolis, MN 55440 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(88) Date of publication of the international search report:
14 December 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** PESTICIDAL COMPOSITIONS AND METHODS

(57) **Abstract:** Certain chemical analogs and related compounds useful in the control nematodes and other pests that infest plants or the situs of plants are described. Nematodes and other pathogens that parasitize animals can also be controlled using the methods and compounds of this invention.

WO 2006/060654 A3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US05/43622

A. CLASSIFICATION OF SUBJECT MATTER
IPC: C07C 211/00(2006.01)

USPC: 564/305,463
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 564/305, 463

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
CAPLUS on STN

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 814264 (CALDERBANK et al) 03 June 1959 (03.06.1959), see entire document.	1-4, 13-16 and 51 (in part)
X	WO 2004/018415 (YAMAGUCHI et al) 04 March 2004 (04.03.2004), see entire document.	1-4, 13-16 and 51 (in part)

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 August 2006 (24.08.2006)	29 SEP 2006

Name and mailing address of the ISA/US	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Brian J. Davis Telephone No. 571-272-2717

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 5-12, 20-40, 57-62, 64, 68, 69, 76-83, 86-88, 94-101, 106-132
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of any additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-4, 13-16 and 51 (in part)

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group 1, claim(s) 1-4, 13-16 and 51 (in part), drawn to compositions and methods of use of compounds of formula (I).

Group 2, claim(s) 17-19, 50 and 51 (in part), drawn to compositions and methods of use of compounds of formula (IIa).

Group 3, claim(s) 41, 42 and 51 (in part), drawn to compositions and methods of use of compounds of formula (IIb).

Group 4, claim(s) 43-45 and 51 (in part), drawn to compositions and methods of use of compounds of formula (IIc).

Group 5, claim(s) 46-49 and 51 (in part), drawn to compositions and methods of use of compounds of formula (IId).

Group 6, claim(s) 52-56 and 63, drawn to compositions and methods of use of compounds of formula (III).

Group 7, claim(s) 65-67, 84, 85 and 90-93, drawn to compositions and methods of use of compounds of formula (IVa).

Group 8, claim(s) 70, 89 and 102-105, drawn to compositions and methods of use of compounds of formula (IVb).

Group 9, claim(s) 71-75, drawn to compositions and methods of use of compounds of formula (IVc).

The inventions listed as Groups 1-9 do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: Each of the Groups has as its unifying inventive concept and special technical feature a particular set of compounds described and defined by formulas (I)-(IVc). These sets of compounds are structurally dissimilar and patentably distinct each from the other.